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THE
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AGRICULTURE IN THE BELGIAN CONGO

In an article* recently published in *Nature* dealing with the proposals for organizing the research services in East Africa, Dr. E. B. Worthington, Scientific Secretary to the East Africa High Commission, remarks upon the provision for similar purposes in the Belgian Congo, a neighbouring region comparable in size. "In the group of subjects concerned with primary production from the soil, the *Institut National pour l'Étude Agronomique du Congo Belge* has an annual subvention towards recurrent expenditure of more than a hundred million francs,† 3 per cent. or so of the whole expenditure on public services in the country."

An appreciation of the scope of I.N.E.A.C., and of the general outlines of the position attained in the scientific study of the agriculture of the Colony can be derived from the study of the proceedings‡ recently received of an inter-African Agricultural Conference held under its auspices in 1947 at Yangambi in the Province of Stanleyville, one of the principal centres of investigation. In addition to a comprehensive representation of I.N.E.A.C. the Conference was attended by officers of numerous other institutions having agricultural interests in the Colony, and by official representatives of agriculture in French and British colonies in Africa.

The major theme of the Conference (which it is hoped may be the first of a series) was the maintenance of the fertility of the soil under the conditions prevailing in central Africa, a subject in which, as was soon revealed, the accumulation of experience has given rise to ever-increasing concern. The history of this experience provides a significant parallel to experience in the British African dependencies as described for Uganda in papers by Dr. W. S. Martin and commented on in this Review in April, 1946. The maintenance of fertility is obviously fundamental to all schemes of African agricultural development, and for this reason we should be wise to learn what we can from a colony in which controlled development has been for long the subject of experience and study by comprehensive organizations with more definite objects, much greater resources, and much stronger administrative support than any which have operated in British colonies.

* "Research Services in East Africa," *Nature*, October 9, 1948.
† Approximately £568,000 at present rates of exchange. ‡ See p. 48.

From a wealth of interesting material we have selected for translation and reproduction in this issue the opening lecture delivered by M. J. Henry, Head of the Agronomic Research Section of I.N.E.A.C. which provides in picturesque outline the history of European experience of agriculture in the Congo from the time when its luxuriant vegetation inspired the pioneers with visions of rich rewards from the exploitation of its soil. Successive stages of disillusionment are revealed. The results of the application of European methods, or (as another speaker put it) their caricatures, soon proved the futility of their transference to tropical conditions. Other countries had long-established tropical plantations; these must be studied and their methods copied. That was the next stage, energetically entered. The result experienced: good crops at the outset, quickly decreasing with the degeneration of the soil. All the conventional measures to meet this situation have been applied: the conservation of the original wealth of organic matter instead of its incineration; the use of cover-crops and green manures; experimental applications of organic manures and chemical fertilizers; rotation of short term crops. The results of any of these measures are admitted to be disappointing, especially as regards their effect in maintaining a healthy physical condition of the soil.

In comparing this experience with that in our own colonies it is necessary to bear in mind the nature of the soils involved. Most of the developments referred to appear to have taken place in the equatorial forest regions. We too know by experience how delusive can be the idea that heavy forest growth necessarily denotes an inherently fertile soil. In the course of long ages an almost pure sand can accumulate sufficient organic matter to develop dense forest cover and, under its protection, to maintain indefinitely the cycle of growth and decay. When this cycle is interrupted by clearing operations, the accumulated capital is quickly dissipated by the many agencies at work, stimulated by exposure to the tropical sun. If this process is not allowed to go too far secondary forest will re-establish itself, but there is great uncertainty, and some controversy, as to the time required for really effective restoration. The lighter the soil, in general, the longer the period, and in really poor soils it is far beyond any practical prospect of renewed utility.

In the British African colonies at any rate, the native populations have developed in areas where the soil was good enough to permit of regeneration within a period reasonable in relation to the area available. There has now arisen an imperative demand for the exploitation of the areas hitherto disregarded, including great expanses of inferior soil. It seems only too probable that the lessons learned in the Congo will be repeated, at great expense, elsewhere, and the sponsors of the schemes concerned would do well to study the volumes under notice. No more significant evidence could be given of the futility of the rape of Africa, using the

bulldozer to establish monoculture, however great the necessity or impressive the resources available.

With the experience described behind them, the agronomists of I.N.E.A.C. have realized that there is something worth considering in local traditional practice, previously disregarded or even despised. We leave to the eloquence of M. Henry the description of this conversion and proceed to outline its consequences, as developed in more detail by other contributors to the Conference. There is no contention that all the indigenous cultural practices are good—some of them have unfortunate consequences—nor that they are incapable of improvement, but that it is essential to take them into account and to aim at their evolution rather than their transformation. They have a basis of adaptation to the people, the climate, the soil, and the plant which must be respected.

Circumstances, however, have changed. To meet the needs of increasing populations and to provide the export crops which the development of the colony demands, unaccompanied by progressive deterioration of natural resources, it is necessary to practise greater economy in land use. The unregulated scattering of cultivated plots over the country-side, often at considerable distances from a settlement (since the untutored African never regards walking as a hardship) is obviously wasteful. The development contemplated is to persuade or direct the wandering cultivator to settle down and become a peasant with a fixed location. To this end the policy of *lotissements* has been devised.

The system underlying this policy has been described in some detail in a previous issue of this Review (Vol. XXV, 1, p. 45). It will suffice to explain that it depends upon the allotment to each able-bodied cultivator in a social group or unit of a selected and measured plot of land sufficiently large to permit of a succession of the crops appropriate to the region, followed in rotation by a fallow period judged to be long enough for the regeneration of soil fertility. The plots of a community are arranged side by side, in strips, and a given area of each, and no more, is to be cleared and cultivated each year. The individual allotment, in examples described, is from 6 to 8 hectares, and the area cleared annually about half a hectare.

It is obvious that such an arrangement immensely facilitates inspection and the application of advice or direction by the authorities. It also facilitates communal activities and the application, from outside sources, of any assistance available, such, for example, as measures of protection against pests or diseases. It is equally obvious that the transition to such a system involves difficult social problems, calls for a large amount of supervision, and requires on the part of the native acceptance of a degree of direction such as most authorities are now agreed is essential for any notable advance upon his present system and is, furthermore, necessary for the permanence, under modern conditions, of his means of existence.

MISS HILDA L. BARNES

With the issue of this number of the Empire Cotton Growing Review, Miss Hilda L. Barnes brings to an end her long association with the journal as Assistant Editor, and we are confident that its readers will unite with us in wishing her every happiness in the retirement she has so well earned. Miss Barnes joined the staff of the Corporation on January 1, 1921, and has thus completed 28 years of service. Her association with the journal dates from the appointment of Dr. Willis as Editor with effect from October 1, 1923, in preparation for the issue of the first number in January, 1924.

Foremost among the many duties which Miss Barnes has carried out is the compilation of the abstracts from the literature relevant to cotton-growing and cotton technology which have been a feature of the journal from the first, and in the years of the recent war alone maintained its continuity. This duty calls for a wide range of appreciation and the exercise of a critical ability for selection which Miss Barnes has successfully applied. In relation to the more mechanical details of production, her tactful handling of the many delays and difficulties inseparable from the war and post-war periods has done much to overcome them and so enable the regularity of the issue of the journal to be reasonably well maintained.

AGRICULTURAL PRACTICES IN RELATION TO SOIL CONSERVATION*

BY

J. HENRY,

Chef del a Section du Recherches agronomiques de l'I.N.É.A.C.

THE distinguished men who organized the Yangambi "Agricultural Week" adopted as their slogan, "The conservation of the natural fertility of the land." The occasion, therefore, seems to me opportune to recall briefly the stages of development of our cultural practices in Central Africa. Nature has perhaps been generous, but she has also been jealous and secretive, so that the road which we have already travelled has been long and often hard.

At the end of a full day's work, the farmer turns round for the last time to review what he has accomplished, partly to satisfy a reasonable feeling of pride, but chiefly in order to settle what he will do the next day. In the same way, I feel that we should examine the progress which we have made in order to mark out more clearly the next steps.

Achievements in our field have been vast, but new tasks lie ahead; each completed project reveals unexpected prospects and raises new problems. Mother Earth, the source of all lasting riches, surrenders her treasures only to the careful and industrious, to those who understand her well and treat her with respect.

Let us try to imagine the dreams, the schemes and the visions of the future which the rich vegetation of the Congo inspired in the explorers, soldiers and missionaries who were the first to travel through the great equatorial forests. Some of those pioneers must have been farmers' sons, who in their hours of leisure studied the thick, strong covering of plant-life, and dreamed of transforming it into rich pasture and fertile ploughland on the generous European pattern. We, too, at the beginning of our colonial career, gave our attention to similarly fantastic projects. But this concern was a most laudable sentiment for a colonist to entertain; for none of us would flatter himself that he could have appreciated, before he experienced it, the paradoxical fact that the natural resources were too rich to be favourable to agriculture.

The growth of plants is pre-eminently subject to the laws of biology, and every vital process varies in accordance with environment in such

* Translation of an address delivered to the delegates to the Yangambi Conference of the Institut National pour l'Étude Agronomique du Congo Belge, 1947. Reproduced by permission from the *Comptes Rendus de la Semaine Agricole.*

a way that it exhibits an optimum, to exceed which involves rapid deterioration.

Now farming is just the sum total of a great number of biological laws, and consequently never escapes their rule. In the tropics many factors reach, or even surpass the physiological optimum, and man's efforts to improve one factor are vain if others exceed the critical limit. Paradoxical as it may seem, farming prospers most where none of the factors affecting production runs to excess.

In the beginning, agricultural progress in Central Africa was slow and laborious. The reason for this was surely that factors I have mentioned had passed the optimum. Dense growth renders forest clearing difficult, mosquitoes sap the farmers' strength, tsetse-fly precludes the use of draft animals, termites hinder constructional work, overactive bacteria sterilize the soil, and, finally, fungi ravage newly planted areas. . . .

In spite of the constant care which they devoted to agricultural development, we cannot wonder that the pioneers were continually held up by these diverse obstacles. They clearly considered that the road to progress lay through the rigorous application of the recognized agricultural practices which had proved so successful in temperate climates; but experience very soon showed that it was pointless to use traditional and highly evolved European methods of agriculture. Similarly, it seemed that native practices did not conform to any precise law, and that no profitable lessons could be drawn from them. The Agricultural Officers of the *État Indépendant du Congo* were so frequently called away to discharge their many duties that they scarcely had the time to lay bare the very tenuous links which united these native practices.

The initial optimism, the enthusiasm, and the determination of our early agronomists could not survive these numerous failures. As early as 1895, on his return from a tour of the Congo, the eminent Professor and agronomist, Emile Laurent, issued what amounted to a declaration of insolvency. Abandoned to pure empiricism, these many early plantations of the *État Indépendant du Congo* could not but be in danger of failing.

In 1908, at the time of the foundation of the Belgian Colony, agricultural production was insignificant. Nevertheless, certain clear-sighted and truly courageous people energetically defended the theory of the probable preponderance of agriculture as a factor in colonial prosperity. Doubtless they based their opinion on the remarkable agricultural developments that had taken place shortly before that time in certain tropical countries in the Far East.

The second period in the history of the agriculture of the Congo began in about 1910 under the energetic leadership of the late Director-General

E. Leplae. Thereafter agricultural methods entered a new era: the way seemed clearly defined. It was considered sufficient to adopt those methods that had proved successful in the Antilles, in British India, in Ceylon, Malaya and the Dutch East Indies. There seemed no better plan than to follow faithfully the methods used by the skilful planters of these long-established tropical territories. This appeared a great step forward. But before recommending cultural practices and distributing the plants to be grown, systematic trials were to be undertaken. The old Government plantations of the Independent State were reorganized and became to all intents experiment stations. Others were founded . . . and finally Yangambi, where we meet today to study and discuss the problems of tropical agronomy; Yangambi, the headquarters of the agriculture of the Congo, the heart and brain of I.N.É.A.C.

Let us review the principles underlying the agricultural practices which were put to the test in these early stations. The first requirement of a rational system seemed to be to mobilize the greatest possible number of useful elements in favour of the cultivated plant. To this end it seemed appropriate to select the land of the virgin forest which was, by repute, very rich. Thereafter, the necessity for putting the maximum possible quantity of assimilable elements at the disposal of the plant was the justification for cutting down the trees and undergrowth, dragging out the stumps, burning all timber, and working the ground assiduously. To preclude all competition by destroying even the smallest weeds continually and with great care seemed to be a necessary condition of success; an outlook in which we may still recognize traces of the precepts of European agriculture. Pure stand, for example, was unanimously considered essential to success.

The most important result of all this was that the land was rapidly exhausted. It became a general fact that the cultivated plant matured unduly early. The return from the plantations seemed most uncertain. It is true that the first results of selection corrected the obvious setbacks to a certain extent, but they could not completely disguise the unsuitability of the cultural methods.

Under the direction of excellent agronomists who were well acquainted with the progress of tropical agriculture, new measures were tried. The use of cover crops and green manures became current practice. Later, at the instigation of my regretted predecessor, A. Beirnaert, new methods of opening up land without burning the forest cover were put to the test, and many trials with organic and inorganic manures were laid down at our experiment stations.

In the course of a few years, the results of all these experiments showed that these practices were nothing but questionable palliatives, generally of little economic value. The exhaustion of the soil was not

stopped, but barely slowed up. The duration of many of our perennial plantations seemed all too short. These results were worth following up, but above all it became necessary to discover why cultural methods which were so satisfactory elsewhere proved so inadequate in our territories.

In the present state of our knowledge the essential elements of the answer seem to me evident. The ecological conditions which prevail in the heart of this Continent are very different from those which prevail in tropical countries where agriculture is highly evolved. Quite apart from the characteristics of the soils, which are much more favourable in the Far East, there is one basic factor, to which one of our members has already drawn attention, which conditions all the others. This factor is the climate of Central Africa, which is of continental type. Rainfall is relatively poor and variable, and the amount of sunshine is limited and poor qualitatively. These condition all the other climatic factors and reduce the general standard of natural fertility.

At this stage of my address I should be sorry to leave you with the impression that the balance-sheet is unfavourable. If I harp on the weaker points of our agricultural methods, it is because I wish, on the other side, to put the emphasis on the step which, I am convinced, is in reality the starting-point of new and fruitful progress. In fact, a great number of agricultural enterprises are now working very profitably, and the production of native agriculture goes on increasing.

For several years past there has been noticeable progress, resulting from new ideas put into circulation by our research workers, which are gaining increasing favour with our planters. Here let me pay a tribute to the mutual understanding which exists between the agronomists and planters of the Belgian Congo, thanks to whom the agricultural development of the Colony goes forward from strength to strength. While valuable lessons may be learned from the fine research work carried out abroad, the true and ultimate solution of our agricultural problems is to be found in the study of all the factors of our particular physical and biological environment.

A great point was made by A. Beirnaert when he stressed how much more irrational cultural methods exhaust the soil than does the cultivated plant itself. "Soil husbandry" and "plant husbandry" are two distinct, and often contradictory, things. The latter gives an immediate, but uncertain return; the former seeks to maintain harmony in equilibrium.

The practice of not burning off has been brought back into favour. Ploughing has been abandoned, and weeding reduced. We now strive for a continuous and dense cover for the soil, an equilibrium in, and a reasonable return from, the components of the soil, and a complete

and balanced utilization of ecological conditions. Systems of mixed cropping are recommended; the employment of long periods of fallow is envisaged, as much for annual crops as for those which have a vegetative cycle of many years. These are now the principles behind our cultural methods, and these are, without doubt, profitable paths which we must follow resolutely.

I propose to give you now some details of the development of these principles with particular reference to food crops, though in fact there is little difference between these and crops with a long vegetative cycle. The principles governing both are identical, and it is only the differences in the duration of the cultivation-fallow cycles which lead to modifications in their application. The agricultural methods adopted by the *Division des Plantes* in 1932 still showed considerable traces of European ideas, and were inspired to some extent by practices in favour in the Far East. Complete burning off followed the clearing of the forests. Complete stumping was followed by deep ploughing. For a year the earth was protected by leguminous cover-crops, *Calopogonium* or *Pueraria,* which were dug in before cultivation began. Three weeks before sowing, the ground was carefully prepared with further ploughing, hoeing and harrowing. Cultivation was continued without interruption through the following rotation: rice, groundnut, cassava, and finally a leguminous cover-crop to be dug in before sowing started again.

It was not long before the deterioration of the soil became apparent. By 1940 the majority of the experimental plots had carried two complete rotations. The yield of rice had fallen to one-fifth, and of groundnuts to one-sixth of initial yields. What lessons can we learn from these experiments ?

In our inherently poor land, the fertility of the soil is first and foremost a question of the maintenance of organic colloids. Soil structure, water content, the mobilization of mineral elements, everything, in fact, which affects fertility is directly dependent on this. Little is known about the evolution of organic matter in soils subject to such peculiar environmental conditions as we find here, and it is only in the future that we shall be able to discover the true mechanism of these transformations.

Whatever may be the case, it is clear that there is a limit of temperature beyond which the transformation into minerals of organic colloids is more rapid than their formation at the expense of plant refuse. The speed of this destructive process, which amounts in the widest sense to a form of combustion, is a function of the degree of dispersion of the surface soil. The more the soil comes into contact with the atmosphere, the more rapidly it is changed. It follows, therefore, that once the forest is felled, the brushwood and plant débris, sweltering in the open

air at a high temperature, rapidly decompose, and the balance of the reaction of equilibrium between organic raw material and organic colloids is disrupted. The soil is stripped bare for the greater part of the rotation, and subjected to the action of the sun. Frequent ploughing and weeding lead to soil erosion, and the mineralization of organic complexes. Attempts to remedy the position by the use of leguminous crops have proved insufficient and temporary measures with which to counteract the high temperature of the soil. Burying these masses of vegetation with an unduly high cellulose content only serves to accelerate a process of decomposition which is already too active.

That is the picture of the evolution of our soils in the framework of our methods, and it is perhaps even now painted in too cheerful colours. I will not dwell on the injurious results of gully erosion, sheet erosion and the ruining of the soil structure.

You will note that in this review of the evolution of our ideas about agricultural methods, I have hardly mentioned native practices. You may ask whether we should really speak of them only to decry their value, and whether they were, in fact, purely empirical. Certain of our leading agronomists soon established the necessary discriminations. I should like to mention here the name of the late R. P. Hyacinthe Vanderyst, one of the leading agronomists of the Congo, as well as others to whom we have had the pleasure of listening today. The value of certain of these methods of soil conservation has been quite rightly emphasized. It is false to claim that all forms of native agriculture are detrimental to the soil. In view of the difficult conditions prevailing in other parts of Africa, we cannot deny the tribes of the Central Basin a certain skill in establishing their practices. Let us consider the chief characteristics of their method, known contemptuously as "Bantu," and currently practised, with some variations, by the natives of the equatorial forest zone. It can be summed up as follows:

Ploughing is forbidden, on the grounds that forest fallow disturbs the soil sufficiently. Cleaning out of stumps and roots is not practised, so that the soil gets the maximum benefit from the ligneous material produced during the fallow. The native practises a system of mixed cropping which practically never leaves the soil bare. Lastly, the regeneration of the soil is assured when the plantations are abandoned after a very short cultural cycle and become forest once more through the medium of that admirable grouping of plants, that marvel of structural organization, that model of biological equilibrium, and that efficient utilization of environment which constitutes the *Forêt à parasolier*.

Is this not an adequate reply to all the difficulties which we have just recounted? Are we not, in fact, rejoining the traditional road to all human progress which, backed by knowledge gained in practice,

develops step by step as methods thoroughly approved by the often tragic experience of many generations can be justified and improved? Without a doubt, this is the traditional way. It is a safe road along which we can go forward resolutely. But our long and devious journey has led us to pick it up again far back, indeed too far away from its end, which appears, as it were, confusedly on the horizon of our aspirations. It is only a narrow track, which must be widened and straightened, and made to suit the circumstances and the ever-increasing needs of our growing economy.

The work of realizing this plan has already begun. Since 1940 exploratory trials have been going on with the object of comparing the different types of native agriculture; with the necessary qualifications experiments were similarly designed to discover the possible application of these methods to more intensive agricultural production. You will, of course, Gentlemen, have the opportunity of visiting several of these experimental plots, and you will gather from them what influence the boundaries of the forest have on the way in which they are laid out, and how the fields are arranged in corridors in order to facilitate the occupation and the reafforestation of land after it goes out of cultivation.

Several types of fallow are being studied, some natural and some artificial. It is important to know very exactly what different evolutionary sequences follow the abandonment of a field. There are very noticeable differences according to whether there has been a short cycle of cultivation, or a long cycle of exploitation; whether the opening up of the fields has been accompanied by burning or not, and whether cultivation has followed immediately after clearing or has been deferred for several seasons.

It is a fact, though paradoxical, that the study of fallow acquires as great an importance as the study of cultivation.

The following are the essential general recommendations which we can single out at the moment. They offer some firm ground on which to work, and have a sufficiently general application.

Pure stand must not be used. I hasten to define what I mean by pure stand. A plantation of a given species, grown alone, which includes no other species, whether wild or cultivated, or in which man intervenes to prevent all other plants from growing, is a pure stand. From the moment at which the planter skilfully grows different kinds of plants in the same field, he is indulging in mixed cropping; the fact that certain of the constituents in these "associations," as we may call them, may give an immediate return or one which is simply deferred, is of little importance. A field of rubber in which the spaces between the rows are occupied by recurring forest growth skilfully graded is an example of mixed cropping, although the recurring growth has only an indirect economic interest in the shape of a calculated improvement in

the production of latex, thanks to the effect on the maintenance in good condition of the soil and the trees. If in the same field, in the same spaces, we plant coffee, thus reducing the importance of the recurring growth, we have an example of mixed cropping in which both of the elements are of direct economic importance.

Conversely, if this same plantation of rubber had been more closely spaced, with clones having particularly dense foliage, very few plants could have germinated or lived under such a cover; no recurring growth would have been established in the spaces between the rows, and our field of rubber would have been a pure stand.

The ideal example of mixed cropping or agricultural association would be one which included in successive stages plants which are progressively less exacting in their demands with regard to light (thus ensuring sufficient protection for the soil to keep its temperature below the critical limit) and are capable of exploring systematically all the layers of the soil, eating and drinking, as it were, not from one table, but from many tables under the same roof.

What must at all costs be avoided is the exploitation of any one particular layer of the environment both above and below ground. To a uniform aerial layout of foliage corresponds a uniform root layout, distributed in a normally narrow layer of the soil, at a level appropriate to the plant under consideration. It is in this layer that all the vital processes of absorption of water and mineral salts take place.

The general circulation of water in the soil is then disorganized. The taking up of water by the plant is confined to a relatively thin layer where the solutions become unduly concentrated to the point of precipitation. The soil profile is altered and becomes an obstacle to maintaining the balance of the root system itself. The structure of the soil alters, its water and air content changes. . . .

But elaboration is unnecessary, as these are the very terms which I used before.

Besides this principle of "agricultural association," for which we can keep the name of mixed cropping where several economic crops are involved, there is a second principle, that of the fallow.

Unanimity is in process of being reached on the principle of a resting period for the recovery of the soil after a cycle of annual food crops. I am convinced, Gentlemen, that the same principle will one day be established for those cultivated plants which have a longer vegetative cycle. But what will this resting phase be? Natural or artificial fallow? Controlled wasteland or beneficial cultivation between two successive cycles? The principle seems well accepted, but its realization raises many problems, which rightly occupy your attention. As proof of this I need only cite the great number of papers to be discussed during the course of this week which bear on this very point of the

"recovery" of the soil. Keeping within the limits of the Congo forest basin, in which I am stationed, I shall not hesitate to acquaint you with my conviction that forest vegetation alone will be capable of assuring the complete recovery of our exhausted soils. But should this forest necessarily be of that final heavy type with which we are acquainted, which takes so long to establish, or should it be that admirable secondary *forêt à parasolier* which is so quick to occupy our lands in the role of forest? Should not this fallow period become one day one of the most interesting elements economically in the pattern of the culture cycle, thanks to the rational exploitation of the produce of the forest, or by the addition of plants useful for various purposes? Shall we not come one day to the point of curtailing, or even completely suspending this interruption, thanks to the adoption of agricultural associations which themselves provide all the benefits of the natural forest environment with its salutary ecological effect? Shall we not eventually reach the stage of bettering this effect by introducing manures or mineral fertilizers?

I beg your pardon, Gentlemen, for ending this exposition with such an impressive series of questions, which I leave to you rather starkly, without giving adequate answers. But there I see the justification for this "Agricultural Week." The task remains vast and difficult, but fortunately workers are coming forward in great numbers. I am convinced that our exchanges of views will result in a salutary and successful clarification of the points at issue. Progress is being made, and good will is not lacking; if we co-operate and redouble our efforts we shall, in this country, win the great and ever-present *Bataille de la terre.*

SPINNING TEST METHODS—SHIRLEY INSTITUTE, 1948

BY

C. UNDERWOOD,

Shirley Institute, Manchester

An important section of the work of the Shirley Institute is that concerned with spinning tests on cotton samples. For many years, samples of experimental growths have been received in increasing numbers from cotton breeders in many parts of the Empire, as well as from other sources such as the Egyptian Ministry of Agriculture, the Compagnie Cotonnière Congolaise of Brussels, and the United States Department of Agriculture. In addition, tests are now made for the Raw Cotton Commission on samples representing practically all the important commercial types of cotton imported into this country. The results of most of these tests are published regularly in the *Shirley Institute Bulletin*, a confidential publication for members of the British Cotton Industry Research Association, whilst the senders of the samples receive, of course, detailed reports on their own material.

A description of the procedure of the tests was given in the *Shirley Institute Memoirs*, 1935, vol. xiv, Appendix[5]; not only is this account, however, somewhat out of date, but a certain amount of technical knowledge of cotton processing was assumed. The purpose of this article, on the other hand, is to give senders of samples an account of the tests to which their cottons are submitted and an explanation of the terms used in the cotton and spinning test reports; it is intended primarily for cotton breeders and others whose interest lies not so much in the details of the processing as in the interpretation of the results.

Two types of spinning tests are now in use at the Shirley Institute, (*a*) the large-scale spinning test, briefly denoted by ST, and (*b*) the small-scale spinning test (SSST). The former is basically the same test as has always been used, whilst the latter is a comparatively recent development (1940) designed for the rapid testing of quantities of cotton much smaller than that required for the large-scale test. The procedure is rather different for the two tests, which will therefore be described separately. The fibre tests, which are made on all ST samples and on as many SSST samples as time permits, are the same for both, however, and follow the basic methods described in *Shirley Institute Memoirs*, 1932, vol. xi, No. 1.[1] Since the publication of that memoir the conception of "standard fibre-weight" has been introduced[4];

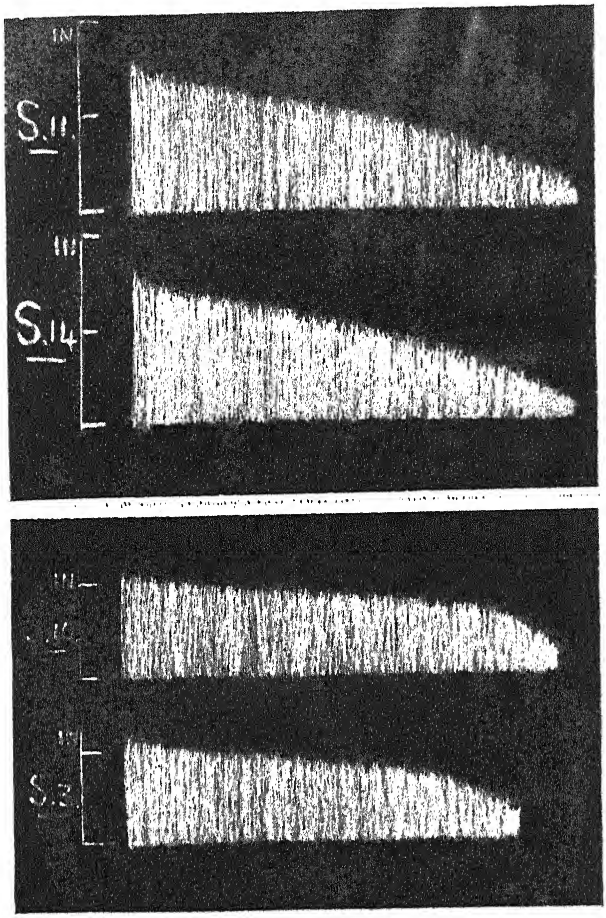

FIG. 1.

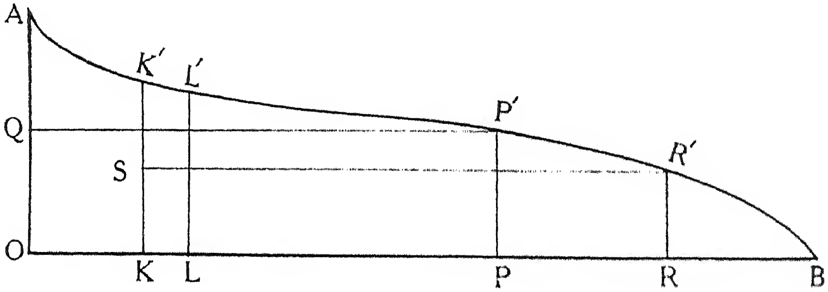

FIG. 2.

To face p. 15

because of this, and for the sake of those who are unfamiliar with the fibre-testing methods used, it has been thought advisable to include a brief outline of the fibre tests made on spinning test samples.

Fibre Tests

When the cottons arrive at the Shirley Institute, they are checked against the Schedule of Information which should accompany them, numbered* and sampled. Two samples, generally called "envelope samples," each consisting of at least 50 tufts picked at random and weighing about 30 gm., are taken from every grower's sample. Four different observers take independent "fibre test samples" of about 15 mgm., two from each of the two envelope samples, and it is upon these fibre test samples that the actual tests are made. Firstly, a sorter diagram (Fig. 1) is prepared by means of a comb sorter,[1] the fibres being laid at uniform density on a black velvet pad, their lower ends along a horizontal base line. The line passing through the upper ends of the fibres provides a curve from which the length characteristics of the cotton can be obtained by a simple geometrical construction.

In Fig. 2 the curved line represents the trace obtained from a sorter diagram, OB being the base and OA denoting the longest fibre. The point Q is fixed by bisecting AO. KK^1 is drawn at one-quarter of the distance from O to P and is bisected at S, and OL is one-quarter of the distance from O to R. LL^1 is the *Effective Length* (column 3† of Cotton and Spinning Test Report Form) and $\frac{RB}{OB} \times 100$ gives the percentage of *Short Fibre* (column 4).

The effective length is substantially independent of the amount of short fibre present in the sample, in which respect it differs from the mean length. When the percentage of short fibre—a measure of the irregularity of staple—is high, the mean length bears little relation to the practical working length of the cotton; the effective length is therefore preferred as a measure of the staple, especially as there are also simple connections between the effective length and commercial estimates of staple length such as the American standards.[2]

The sorter diagram trace having been obtained, five bundles of fibres are removed from the diagram at roughly equal intervals along the base line. From these bundles, centimetre lengths are cut by a special cutter consisting of two safety-razor blades fixed in a holder with their edges parallel and 1 cm. apart; 100 of these fragments are counted

* In the system which has been in use for many years at the Shirley Institute, there are three series of numbers: "X/E" for experimental cottons from the Empire Cotton Growing Corporation, "X" for experimental cottons not from the E.C.G.C., and "C" for commercially grown cottons from whatever source.

† See List of Column Headings at end of paper.

from each bundle, and weighed on a sensitive micro-balance.[3] From these weighings the mean *fibre-weight per centimetre* is calculated (column 6 on the reports).

Bundles of fibres adjacent to those used for the fibre-weight per centimetre determination are now taken and immersed in 18 per cent. caustic soda solution; the fibres swell and, when examined under a microscope at a magnification of about 150, can be classified according to the form assumed into three groups—" Normal," " Thin-walled," and " Dead." The *maturity* of the sample is indicated by the percentages of " Normal " (N) and " Dead " (D) fibres (column 5 of the reports). On the more detailed " Cotton Test Report " which has now been generally superseded, a figure known as the *Maturity Ratio*—obtained by a simple calculation from the values of N and D (Maturity Ratio$=\frac{N-D}{200}+0{\cdot}70$)—was also given.

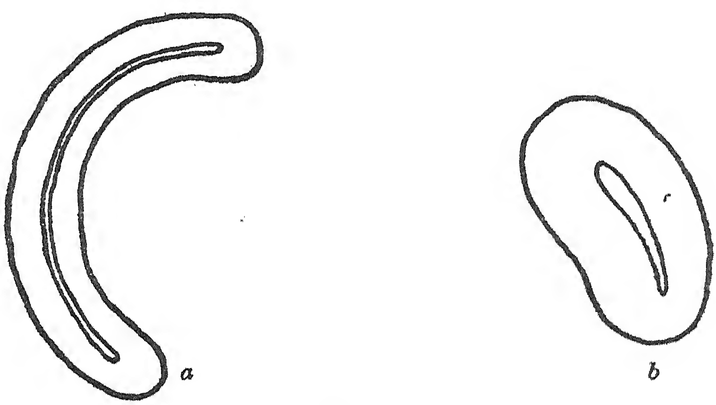

FIG. 3.

The mean fibre-weight per centimetre is dependent upon the wall-thickness—*i.e.*, the maturity—of the fibres as well as upon the more fundamental cell-diameter; it is, therefore, not a reliable index of the inherent fineness of a strain. Thus, two cottons may give the same value of mean fibre-weight per centimetre, yet their fibres may be geometrically quite different, those of one having large diameter and thin walls (Fig. 3*a*) contrasted with the small diameter and thick walls of the other (Fig. 3*b*).

The fineness of a strain is, therefore, better expressed by the *standard fibre weight per centimetre*[4] (column 7 of the reports), which is the value that the mean fibre weight would attain at a standard maturity—viz., $N-D=60$ or Maturity Ratio unity, the relation between maturity ratio and mean fibre-weight being assumed linear for any one strain. The standard fibre-weight is obtained simply by dividing the mean fibre-weight by the maturity ratio.

In the routine spinning tests made for the Empire Cotton Growing Corporation and other similar bodies, the fibre tests are confined to the measurements described above—viz., effective length, percentage short fibre, mean fibre-weight per centimetre, maturity, and standard fibre-weight. It has been found[5] that differences in these quantities are generally sufficient to account for the major portion of the variation in spinning quality of different cottons. Thus, yarn strength is positively correlated with effective length, negatively with standard fibre-weight; in other words, longer and finer cottons generally spin stronger yarns than shorter and coarser ones. Again, low percentage of short fibre is desirable, because not only does irregularity of staple sometimes reduce yarn strength, but it almost always results in greater waste losses in processing. Maturity is important with respect to yarn appearance, as will be seen from the discussion of yarn quality later in this article, as well as from a recent contribution to this Review[8] on the subject of neppiness, and, generally speaking, a high maturity ratio is desirable. When all these factors have been taken into account, however, there still remains a residuum of unexplained variation in yarn quality which sometimes attains serious proportions. Glaring anomalies occasionally appear, or perhaps for some reason or other a more accurate appraisal of cotton quality is desired, and in these cases additional fibre tests may be made. The most obvious choice appears to be fibre strength. Tests for fibre strength are not included in the routine described above, partly because no really satisfactory and sufficiently rapid test from which consistent results could be obtained has been available until recently, and partly because, since longer and finer cottons are usually stronger per unit weight of fibre than shorter and coarser ones, the effect of strength is generally masked by the effects of length and fineness. When this correlation breaks down, however, an anomalous result may appear, and in such instances a measurement of fibre strength may be found to explain the anomaly, at any rate in part. Similar considerations apply to other fibre qualities such as inter-fibre friction, convolutions, etc.

For *fibre strength* tests, a modified form of the Pressley tester[6] is used. A flat combed bundle of cotton fibres is firmly held in two specially designed grips and an increasing load is applied through the movement of a weight sliding at a controlled speed down an inclined plane. The motion of the weight is automatically arrested when the bundle breaks, and the position of the weight on the inclined plane indicates the breaking load. Standard lengths of the portions of the broken bundle are weighed on a micro-balance, and the strength is expressed in lb. per unit weight of fibre.

It is not likely that measurements of other fibre properties such as fibre friction, etc., will be included in routine testing in the immediate

future, for no satisfactory test for inter-fibre friction has yet been devised, and the counting of convolutions is much too laborious for routine work. The omission of these tests is not generally a serious matter, however, as the large majority of the results obtained in spinning tests follow the established relations between the measured fibre properties and spinning quality; whenever anomalies of unusual magnitude are encountered, every attempt is made to find a satisfactory explanation.

Apart from the physical properties of the fibres, there is another characteristic of raw cotton that has an important bearing on the processing performance—viz., the amount of trash (non-lint) present. Every cotton inevitably contains some fragments of leaf, seed, stalk, sand, etc., and it is important to be able to estimate the percentage of such impurities when evaluating a sample. By means of the Shirley Analyser,[7] the amount of trash in a given quantity of cotton can be easily and quickly determined; this test has therefore been included in the testing routine for growers' samples sent for large-scale spinning tests. (Samples sent for small-scale spinning tests are usually too small to allow Analyser tests to be made.) A single test on the Shirley Analyser requires 100 gm. of cotton, and one test is usually sufficient, provided that normal precautions have been taken in sampling the original "grower's sample." The result is expressed as Analyser per cent. Trash (column 8 on Cotton and Spinning Test Report for large-scale samples), the figures varying from 1 per cent. for very clean cottons to 7 or 10 per cent. for dirty cottons. A difference of about 10 per cent. of the figure for Analyser per cent. Trash is usually statistically significant.

The Joint Spinning Tests Sub-Committee

All samples sent by the Empire Cotton Growing Corporation for large-scale spinning tests are examined, as soon as possible after their arrival in Manchester, by a sub-committee of spinners known as the Joint Spinning Tests Sub-Committtee of the E.C.G.C. and B.C.I.R.A.,* who comment on the quality and general appearance of the cottons and make recommendations as to the type of yarn for which they are most suitable. The Committee also inspects the yarns spun from the samples, and the opinions expressed with respect to yarn appearance, neppiness, regularity, etc., are incorporated in the final report on the samples. The value of this sub-committee lies not only in the practical opinions expressed as to the quality of the samples examined, but also in the fact that it provides a useful link between the breeders and the industry;

* Examination by the Spinning Tests Sub-Committee of samples sent for small-scale tests is not practicable, partly because of the large number of such samples and partly because of their small size.

by this means new varieties can be brought to the notice of spinners probably much earlier than would otherwise be the case, and the breeders in their turn are in a better position to gain some idea of the trade reaction to new cottons.

Large-Scale Spinning Tests

Processing of the cottons cannot be begun without some knowledge of the fibre properties, enabling appropriate settings of the machines to be made. Fibre tests on ST samples are begun as soon as possible, and are proceeding whilst arrangements are being made for the examination of the cottons by the Spinning Tests Sub-Committee; by the time the actual processing is started some information about the length and fineness of the cottons is generally available. Sometimes, an estimate of length by " hand-stapling " is used; if this is always done by the same person it is sufficiently accurate to enable the settings at the earlier machines—which are less critical than in the later stages—to be decided. The decision as to suitable counts of yarn into which the samples are to be spun must be made before the processing is started, and this is guided by the opinions of the Spinning Tests Sub-Committee and by the results of the fibre tests. (The " count " of a yarn is a measure of its fineness; it is the number of " hanks " in 1 lb., a hank being 840 yards.) Alterations of detail may be found necessary during processing, but the broad outline of the scheme for any group of samples is determined beforehand.

For the treatment of samples weighing 10 lb. or less, it is impracticable to use all the standard machines found in a cotton mill, but the departure from normal mill practice is not important enough to affect the validity of the tests. An amount of cotton depending upon the " preparation " or count range into which the cotton is to be spun (usually 5 to 6 lb.) is weighed out, the remainder of the sample, if any, being kept for repeat tests when necessary. For a satisfactory test 5 lb. is the minimum, though spinnings can be made from as little as 2 lb. In order to allow for the samples taken for fibre tests, Shirley Analyser tests, and examination by the Spinning Tests Sub-Committee, it is clear, therefore, that at least 7 lb. should be sent to provide enough material for an adequate large-scale spinning test.

The spinning test sample is fed first to a *hopper feeder*, a conventional mill machine designed to " open " the cotton by the tearing action of spiked rollers and lattices, and to deliver cotton at a substantially uniform rate to the next machine, a *porcupine beater*. In this, the cotton is subjected to a beating action by arms projecting from a cylinder rotating at high speed (600 to 800 r.p.m.); by this means, further opening is achieved, and a certain amount of cleaning takes place,

heavy trash being thrown out through a grid below the beater. From this machine, the cotton passes to a *Shirley cage*, a perforated rotating cylinder (90 r.p.m.) through the surface of which fine dust is drawn by means of a fan. Another, more slowly moving *condenser cage* (8 r.p.m.) follows, from which the cotton, now in a fairly open state, is deposited in a bag. It is then fed by hand to a *scutcher*, in which further beating takes place, and from which the cotton is delivered in the form of a "lap"—a continuous sheet of material about 6 yards long and $1\frac{1}{4}$ yards wide conveniently rolled into a compact cylinder. This is then unrolled and fed four-fold to the scutcher for a second passage, from which the "finisher lap" is obtained—cleaner and more regular in thickness, as the fourfold feed gives opportunity for the thick and thin places in the original lap to "cancel out." The feeding of superimposed lengths of material to achieve greater regularity is technically termed "doubling";* it is met with in various stages of mill processing, the most important application being at the drawframe (see below). The "finisher lap" from the scutcher is fed to the card, and from this point onwards the processing in the large-scale spinning test is essentially the same as in mill practice. In the card, further cleaning takes place, and the cotton, subjected to the action of opposing fine steel wire points separated only by a few thousandths of an inch, is disentangled and opened largely to single-fibre state. The fibres are then re-combined and compressed to form the rope-like "sliver."

In the next machine—the *drawframe*—a number of slivers (usually 6 or 8) from the card are combined and "drawn out" or "drafted" by means of pairs of rollers driven at progressively increasing speed; the resulting sliver is of about the same thickness as each of the 6 or 8 slivers from which it was obtained, but more regular, whilst the fibres composing it are more parallel. This process is repeated twice, the final sliver resulting from the third passage through the drawframe possessing enhanced regularity and parallelism, as a result of the repeated combination of a number of slivers—an important instance of "doubling," mentioned above.

After the drawframe, the material passes generally through three very similar machines known collectively as the "*speed frames*" or "*fly frames*," and individually as the "*slubbing frame*" (or "slubber"), *intermediate frame* ("inter") and *roving frame* ("rover"), each of which performs the same functions—viz., the further attenuation of the product, the insertion of sufficient twist to give cohesion to the thin strand so that it is not damaged by stretching, and the winding of the twisted strand on to bobbins for convenience of handling and transference to

* Not to be confused with the same term applied to yarns, denoting the twisting together of two or more "single" yarns to produce a "doubled" or "folded" thread—*e.g.*, sewing thread.

the succeeding frame. It is generally considered inadvisable for the degree of attenuation or " draft " at any one frame to exceed certain accepted limits (which depend to some extent on the cotton)—viz., about 8 on the drawframe, 5 or 6 at the slubber, 7 at the inter, 8 at the rover, and it is for this reason that three (and sometimes four) speed frames are employed to do what might at first sight seem to be possible on a single frame. The limitation of the draft is due largely to the difficulty of controlling the fibres (which vary, of course, in length) by means of the simple system of pairs of rollers, and many special drafting systems have been devised to effect better control of the fibres during drafting and thus enable higher drafts to be used in any one frame. In the small-scale spinning system described in the later part of this article, use is made of one such drafting system.

From the last of the speed frames, the material passes to the spinning room, and in spinning tests the *ring frame* is always used in preference to the mule, because the latter cannot be efficiently operated with small quantities of cotton. Further drafting takes place at the ring frame, and an appropriate amount of twist is inserted to produce the final yarn built up in a convenient structure on a paper tube or wooden bobbin. The yarn passes from the front rollers of the ring frame through the " traveller "—a small C-shaped loop of steel riding on a highly polished steel " ring "—on to the tube or bobbin carried by the spindle rotating at high speed (7,000 to 10,000 r.p.m.). Twist is inserted by the rotation of the traveller round the ring, and the frictional drag of the traveller results in the yarn being wound on the bobbin. The degree of twist is conveniently indicated by the " twist-factor " (given in the main heading " Yarn Tests " on the ST report form and after the " Counts Spun " on the SSST form)—turns per inch divided by the square root of the yarn count. The strength of a yarn increases with increasing twist-factor up to a maximum, and then decreases as the twist-factor is further increased. In the industry, yarns are spun with varying degrees of twist according to the purpose for which they are intended, but in testing the spinning quality of a cotton it is usual to spin with the twist-factor for maximum strength. The value of the twist-factor for maximum strength varies according to the characteristics of the cotton, but the curve connecting strength and twist-factor has a fairly flat top and the same twist-factor can be used over a wide range of cottons. For short and coarse cottons spun to counts below 32's a value of 4·0 (or 5·0 for very short cottons—*e.g.*, Bengals) is used; between 32's and 80's, 3·75 is found to give strengths approximating to the maximum for most medium-staple cottons, and fine cottons of Egyptian and Sea Island type are spun to counts 80's and above with twist-factor 3·5. Generally speaking, the strength at the optimum twist-factor for a given cotton is a good indication of its

strength at lower twist-factors, and, therefore, the practice of judging the quality of a cotton from its maximum yarn strength level is sufficiently reliable for most practical purposes.

Combing

When yarn of specially high quality is required, an additional process of " combing " is employed. This takes place after carding, and results in a cleaner, more regular product, giving a yarn of enhanced quality. Briefly, the comber removes some of the shorter fibres, nep, and particles of seed, etc., remaining after carding. The amount of waste extracted can be controlled by altering the machine settings, but at any given comber setting it depends on the characteristics of the cotton—its regularity of staple, maturity, cleanliness, etc. Yarn strength and appearance improve with increasing waste percentage up to about 25 or 30 per cent., after which further increase in strength is negligible, though even higher percentages may need to be taken out to eliminate nep from fine and neppy cottons. In such cases, it is generally better to comb the material twice or even three times, extracting, say, 20, 10, and 5 per cent. in the successive combings, rather than to attempt very drastic combing at one stage. Combing adds considerably to the cost of processing, and the higher the percentage lost in combing, the more expensive the process; the percentage comber waste is thus an important factor in appraising the commercial value of a cotton. When combing is included in the Shirley Institute spinning tests it is the practice to comb all except Sea Island cottons at a standard percentage—20 per cent.—so that the yarns spun are directly comparable. For Sea Island cottons, a different type of comber is used, in which the range and ease of adjustment are more limited; samples of this type are, therefore, combed with a standard machine setting, and allowance has to be made for differences in waste losses when estimating the relative values of the samples.

After being combed, the material is again passed through the draw-frame, and the succeeding processes are the same as for cotton that has not been combed. Yarn spun from combed cotton is called " combed yarn," whilst yarn spun from cotton which has not been combed is spoken of as " carded yarn," though it should be remembered that all yarn has been carded, whether combed or not.

Yarn Testing

Yarn is tested for strength on the " lea tester," the machine in common use in the industry. A lea—120 yards—of yarn is wrapped on a special reel and the loop of yarn thus formed, consisting of 80 threads, is placed over the two hooks of the lea tester. The bottom

hook moves vertically downwards at a constant speed (12 inches per min.), and a gradually increasing load is applied to the yarn by the raising of a heavy pendulum (connected with the top hook) up a circular rack. When the yarn breaks, the lea fails to transmit any further load, the pendulum stops and is held stationary by a pawl which engages with the teeth of the rack; the breaking load is read on a dial graduated in pounds. In the routine ST, one lea is tested from each of sixteen bobbins of yarn, and the mean lea strength in lb. obtained. The broken leas are afterwards weighed, and the "actual count" of the yarn obtained; this usually differs slightly from the nominal count, because it is never possible to adjust the draft at the spinning frame accurately enough to ensure the resulting count being absolutely correct. Allowance can be made, however, for small deviations from the nominal count by the use of the "lea count-strength product"—*i.e.*, the product of the actual count and the lea-strength, instead of the simple lea strength, since the latter depends partly on the count, finer yarns being weaker than coarser yarns spun from the same cotton. The use of the lea count-strength product does not fully allow for variations in count, however, as the product itself varies with the count. Fortunately, the relation between count-strength product and count for any one cotton spun at the same twist-factor is linear, and this enables a simple correction to be made, provided that the slope of the line representing this relationship (the correction factor) is known. The relation is of the form

$$P = a - bC$$

where P is the product, C the count, and a and b are constants for a given cotton spun at one twist-factor; b is the correction factor and is obtained from the results of spinnings in two or more counts. It is the change in count-strength product that would be expected to result from a change of one in the count. If two counts only are spun, the "product-count" line is taken as the line joining the points representing the products in the two counts; if three or more counts are spun, the best straight line is drawn by eye through the points obtained. The value of b varies from about 10 for the longest and finest cottons to over 30 for short and coarse cottons, but no consistent relationship between b and the measured fibre properties has yet been established, The corrected values of the lea count-strength product are given under the appropriate count in columns 9, 11 and 13 of the ST report and in column 8 of the SSST report.

Since different cottons may give different values of b, it is clear that the order of strength of two cottons may be reversed in different counts. Consider a hypothetical, but by no means impossible case of two cottons. A and B, spun to 40's and 80's, the results of the tests on which are represented in Fig. 4.

A gives a count-strength product of 2,500 in 40's (denoted by point P), 1,700 in 80's (Q),

$$\text{with } b = \frac{2{,}500 - 1{,}700}{80 - 40} = 20.$$

B gives a count-strength product of 2,300 in 40's (X), 1,900 in 80's (Y),

$$\text{with } b = \frac{2{,}300 - 1{,}900}{80 - 40} = 10.$$

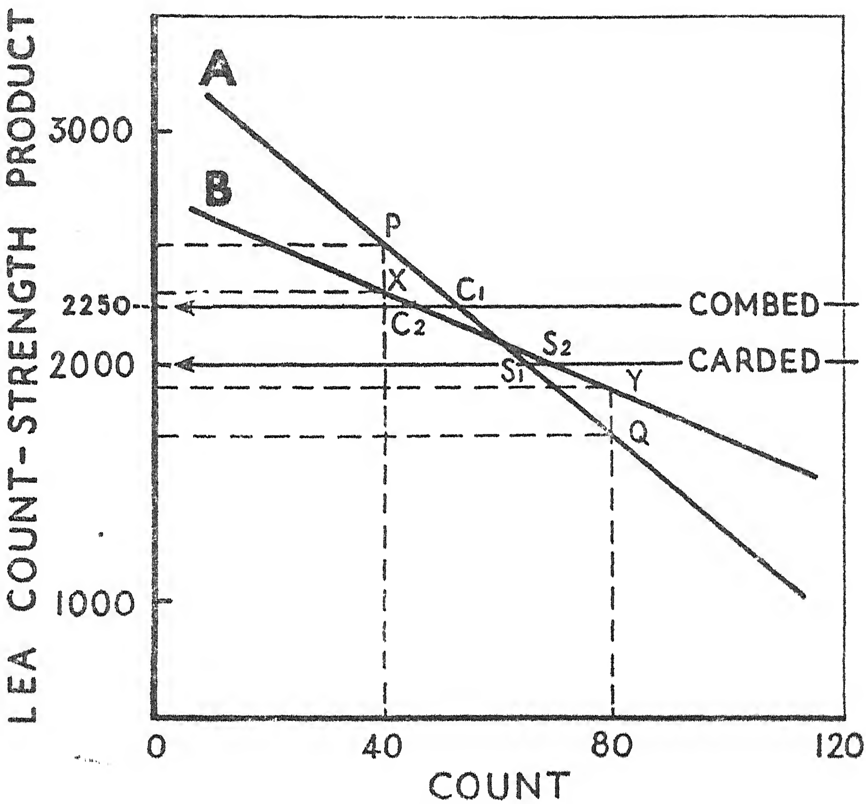

FIG. 4.

Thus no single figure can adequately represent the strength value of a cotton; for practical purposes, however, it is essential to have some simple index of yarn strength, and such is provided by the "Highest Standard Count" (column 15 of the ST report), the count in which a cotton would be expected to give a standard count-strength product when spun under the conditions normally adopted for spinning tests at the Shirley Institute. Two standard values of count-strength product were chosen—viz., 2,000 for carded yarns and 2,250 for combed yarns—and these have been found to give values of H.S.C. corresponding well with the average counts normally spun in the industry from different

classes of cotton, except at the low quality end of the range—*i.e.*, for short and coarse cottons spun to counts below 20's; here, the criterion for H.S.C. is too severe and negative values are sometimes obtained. As such cottons comprise only a very small proportion of the number tested, this difficulty is not considered serious enough to warrant any alteration in the standards. The value of H.S.C. is found simply by noting the intersection of the "count-product" line for the particular cotton with the appropriate standard line—the horizontal through 2,000 for carded yarns, 2,250 for combed yarns. For example, if the results represented in Fig. 4 were from carded spinnings, the Highest Standard Count for cotton A would be at $S_1=64$, that of cotton B would be at $S_2=68$; if the results were from combed spinnings, the corresponding values would be $C_1=52$ for A, and $C_2=45$ for B. Sometimes the same cotton is spun into both carded and combed yarns; then two straight lines are obtained, generally parallel, the intersection of the "combed" line with the 2,250 horizontal being approximately at the same count as that of the "carded" line with the 2,000 horizontal. Slight differences may occur, due to the fact that all cottons do not respond in the same way to combing and to unavoidable sampling errors, etc., but the equivalence is near enough for practical purposes.

Yarn Appearance

Whilst strength is generally the prime factor in the quality of a yarn, its appearance is always important and for some purposes may be of even greater moment than strength, though, of course, of two yarns of equivalent appearance the stronger would always be preferred. In appraising the spinning quality of new cottons without reference to the purposes for which they are to be used, it is difficult to strike a just balance between the claims of yarn strength and yarn appearance, but a yarn of very poor appearance would almost invariably be rejected, however good its strength, just as would an extremely weak yarn of good appearance. The appearance of a yarn is a complex character, comprising regularity and neppiness primarily, with other subsidiary features such as hairiness, ooziness, etc. Regularity is generally related to strength, so that more regular yarns are usually stronger, other things being equal; neppiness, on the other hand, is largely independent of yarn strength, though it often happens that strong yarns are more neppy than weak yarns, because those fibre characteristics which produce high yarn strength—length and fineness—are just those which tend to give rise to nep during processing. Neps—small specks on the yarn, consisting mainly of bunches of fibres—can be produced by faulty setting of the machines, especially of the card, but even with perfectly adjusted machinery it is difficult to avoid nep in processing cottons like St. Vincent Sea Island, and double or treble combing has

to be resorted to in these cases. Even then the danger of nep is not completely eliminated, for neps may be made whenever fibres move past each other as, for example, in drafting.

On the whole, neps are more likely to be formed from an immature cotton than from one in which the fibres are more completely thickened, and therefore a high percentage of normal fibres and a low percentage of dead fibres are desirable. This is by no means the whole story, however, and for a full discussion of the problem of neppiness, reference should be made to the recent article on this subject in the July, 1948, number of this Review.[8]

No satisfactory objective test for yarn appearance has yet been devised, and the method used for spinning test yarns is that of visual examination of the yarns wound on blackboards. The winding is done on a simple machine, the threads being spaced at regular intervals depending on the count of the yarn. After use the boards can be stored for reference.

Yarns spun in the large-scale spinning tests are submitted to the joint Spinning Tests Sub-Committee (see above) for appearance classification, whilst those spun in the small-scale tests are judged at Shirley Institute, the number being too great to be dealt with by the committee. A tentative scale for appearance has been adopted—very good, good, fairly good, fair, moderate, poor, very poor—and placing by Shirley staff who have had some practice, corresponds reasonably well with the placing by the spinners of the sub-committee. It is, however, desirable to have standards against which one's judgment can be checked periodically, and the preparation of such standards is in progress. The yarn appearance classification is given for each count in columns 10, 12 and 14 of the ST report.

In the "Remarks" column, the results of the tests and the sub-committee's judgment of yarn appearance are summarized, attempts being made to pick out the salient points of the report so as to assist the breeder in assessing the relative merits of the samples tested.

Small-Scale Spinning Tests

Samples received for small-scale spinning tests are not submitted to the joint Spinning Tests Sub-Committee, partly because there is seldom sufficient material to enable a useful judgment to be made, and also because of the large number of samples received. "Envelope" samples are taken, as from the ST samples (two from each grower's sample), on which fibre tests are done when time permits. Examination of the cotton by hand-stapling, together with the information given on the Schedule of Information sent with the samples, provides a guide to suitable treatment and machine settings, and the processing

is started immediately. The amount of material needed for the SSST depends partly on the count of the yarn to be spun, finer counts requiring less material; thus, for 40's and above, 75 gm. is sufficient; for 20's, 150 gm. and for 16's or lower 200 gm. or more should be used to allow of an adequate test being made. Duplicate tests are made whenever there is enough cotton.

The material is sampled for the SSST in the same way as for the " envelope " sample—at least 60 tufts being picked from all over the grower's sample to make up the necessary weight. This sampling is important, as it has been found that a serious proportion of the variance between duplicate tests can be attributed to sampling differences.

The SSST sample is " pulled " by hand, to open the cotton a little, and fed direct to a card over a width of about 14 inches; on a card of standard width (45 inches) such as is used at the Shirley Institute for these tests, it is possible to feed 2 samples simultaneously—one at each edge of the card.

The card sliver next passes three times through a drawframe, which differs only in the number of slivers fed (10 instead of the usual 6) from the standard mill machine, after which the sliver is fed direct to the spinning frame, thus by-passing the three-speed frames used in normal mill practice. The spinning frame is specially designed to give high drafts, the possible values ranging from 20 to about 1,000, according to the type of cotton and count of yarn to be spun. SSST samples are normally spun, however, into one of a small range of selected counts—viz., 20's for short-staple American types, 40's for all medium-staple cottons, and 80's for long-staple types, with respective drafts of about 87, 175 and 350. The attenuation of the sliver into yarn, which on the conventional system requires at least four separate machines, is thus achieved in one stage, and this results in a very considerable saving of both material and time. The complete SSST can be finished in about one hour, compared with over one day for the processing of the usual 5 lb. sample on the ST system.

In the SSST, 2 leas of yarn are spun on each of 4 spindles; one lea from each spindle is tested for lea-strength, and the second lea is tested from the two spindles giving extreme values of strength; the remaining leas from the other two spindles are used for blackboard wrapping for yarn appearance judgment. The lea count-strength product, corrected for deviation from nominal count as explained above, is given in column 8 of the SSST Report, and the yarn appearance classification in column 9. No value of highest standard count is given, since spinnings are normally made in one count only. If the fibre tests are completed in time, the results of these are also included in the report, and a general summary is given on the back of the report sheet.

Relation between Large-Scale and Small-Scale Spinning Tests

The value of a spinning test to the breeder depends on the assumption that different cottons are placed in the same order of merit by the spinning test as by conventional mill spinnings. The large-scale spinning test is now generally accepted as a reliable guide to the performance of a cotton in mill spinning; and so, if it can be shown that the small-scale test gives results parallel to—not necessarily identical

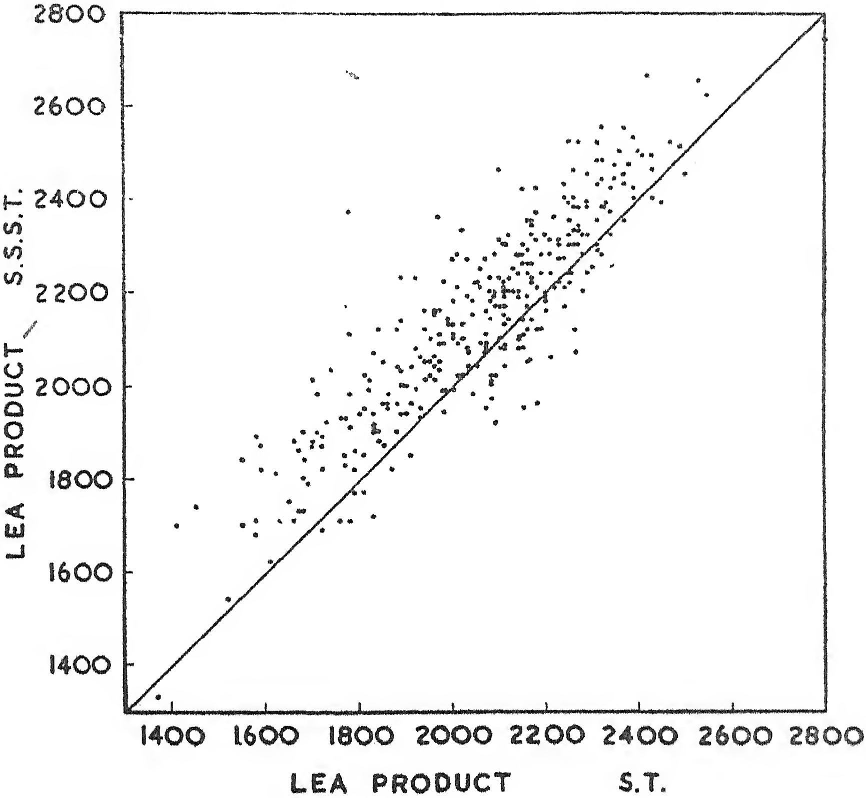

Fig. 5.

with—those given by the ST, its usefulness to the breeder is established. During the past five years, small-scale tests have been made on many samples which have also been spun on the large-scale system, and the results have been compared. In Fig. 5 the results of tests on 323 medium-staple cottons spun into 40's carded yarns on both systems are plotted in the form of a correlation diagram. The correlation coefficient is $+0{\cdot}89$, and the equation representing the relation between the results of the tests on the two systems is:

$$Y=0{\cdot}93X+70$$

where Y is the lea count-strength product in 40's from ST spinnings, X is the same from SSST spinnings.

If the results of the spinnings on the two systems were identical, the points in such a correlation diagram would be distributed about the 45° line passing through the origin; in Fig. 5 it will be seen that most of the points lie above this line, which means that the SSST gives on the whole rather stronger yarns than the ST in medium count spinnings. Further, it has been found that SSST yarns are invariably less neppy than ST yarns from the same cotton. No adequate explanation of this can be offered, but its significance to the grower lies in the fact that the absence of nep in yarn spun in the SSST does not guarantee freedom from nep in yarn spun from the same cotton on the conventional system.

Fewer comparisons have been made with long-staple cottons, and for these it was not possible to make a direct comparison between the two systems, because the SSST yarns were spun in 80's carded, whilst the ST yarns were combed and spun in various counts. Accordingly, a comparison was made between the lea count-strength product in 80's carded SSST and the Highest Standard Count from the ST spinnings. The results of 61 spinnings again showed a satisfactory correspondence between the two tests, the correlation coefficient being 0·88. The equation relating the two sets of results is:

$$Z = +0{\cdot}084X - 78$$

where Z=highest standard count from ST spinnings (combed) and X=corrected lea count-strength product in 80's carded SSST spinning.

Thus, apart from the limitation with respect to yarn appearance, it is clear that the small-scale spinning test can be accepted as a trustworthy guide to the relative performance of a number of cottons in the large-scale test or in mill processing. It is a little less accurate than the large-scale test (smallest significant difference in corrected lea count product: 10 per cent. for SSST single tests, 7 per cent. for means of duplicate tests, compared with 5 per cent. for ST), but this loss is more than compensated for by the great gain in speed and in the number of samples that can be tested.

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Received September, 1948

THE BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION

File..........

COTTON AND SPINNING TEST REPORT. *No*.......... Date..........

On Samples of Cotton from.......... Season..........

HEADINGS OF COLUMNS ON FRONT PAGE

Column.	*Headings.*
1.	*Reference number :* Shirley Institute.
2.	do. do. Grower's.
3.	*Description :* Strain, selection, etc.
4.	Weight of sample (lb.).
5.	*Details of Cultivation* (water supply, soil, climate, pests, etc.).
6.	Date and Number of Picking.
7.	Yield of Lint (lb. per acre)
8.	Type of Gin.
9.	Ginning Outturn.

HEADINGS OF COLUMNS ON BACK PAGE

Column.	*Headings.*
1.	Shirley Institute Ref. No.
2.	Grower's No. and/or description of sample.
	FIBRE TESTS
3.	Effective length (32nds in.).
4.	Per cent. short fibre.
5.	Maturity* N – D.
6.	Mean } Fibre wt. per cm.*
7.	Standard } Fibre wt. per cm.*
8.	Analyser per cent. Trash.
	YARN TESTS (*Twist factor*=
9.	Corrected lea count × strength product.
10.	Yarn appearance.
11.	Corrected lea count × strength product.
12.	Yarn appearance.
13.	Corrected lea count × strength product.
14.	Yarn appearance.
15.	Highest standard count.†
16.	Remarks.

* N=per cent. normal fibres; D=per cent. dead fibres. Maturity ratio= $\frac{N-D}{200}+0{\cdot}70$; Standard fibre weight=Mean fibre weight ÷ Maturity ratio.

† Highest standard count=count in which yarn would be expected to give a count-strength product of 2,000 carded, 2,250 combed. This is not necessarily the highest spinnable count.

THE BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION

SMALL-SCALE SPINNING TEST REPORT No. ....

Samples of Cotton from.. *File*..............................

Season .... *Date received* ....

No. of samples .... *Date of Report*..........................

Counts Spun ....

....

HEADINGS OF COLUMNS

Column. *Headings.*

1. Shirley Institute Ref. No.
2. Grower's No. and/or description of sample.

FIBRE TESTS

3. Effective length (32nds in.).
4. Per cent. short fibre.
5. Maturity* N−D.
6. Mean } Fibre wt. per cm.*
7. Standard } Fibre wt. per cm.*

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8. Corrected lea count × strength product.†
9. Yarn appearance.

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* N=per cent. normal fibres. D=per cent. dead fibres. Maturity ratio= $\frac{N-D}{200}+0{\cdot}70$; Standard fibre weight=Mean fibre weight÷Maturity ratio.

† Differences in corrected product greater than 7 per cent. (duplicate tests) or 10 per cent. (single tests) can be considered statistically significant.

SUMMARY AND REMARKS : (Overleaf).

THE DEVELOPMENT, EXPANSION AND REHABILITATION OF SUKUMALAND*

BY

N. V. ROUNCE,

Senior Agricultural Officer, Tanganyika

INTRODUCTION TO THE PROBLEM

To the cattle-owning African cultivator, occupation means elimination of tsetse fly, reduction of game and vermin, and reduction of ticks by keeping the grass short. In so many words, this means making the country bare of all that shelters the above enemies of man. The result needs little description. Imagine 10,000 square miles of almost unbroken occupation, of gently undulating country with few trees, and many cattle and people and their fields, commonly called " cultivation steppe." Imagine what damage heavy storms of rain do in this open country to 1,000,000 acres of cultivated land, much of which is still inadequately protected from erosion. The 2,000,000 units of stock (5 sheep or goats=1 beast) have devastated many parts of this open country, especially when concentrated too heavily on one area in the dry season, when grazing is short and winds are high. Three quarters of a million people have to find firewood for each fire every day in 120,000 homesteads. 225,000 tons of food have to be produced every year from 880,000 of these acres, much of which cannot be rotated with grass and rested even if the cultivators agreed to do so, because there is inadequate land available. The rainfall is moderate to poor (38 in. to 28 in.), poorest furthest from the lake, and as hot as lake level altitude indicates. Distant from the lake, water supplies are derived from seepage and springs and from holes in sandy river beds. Water is now also impounded in earth tanks, " hafirs " or dams. There is only one river with a permanent flow, which is very sluggish indeed in the dry season. This is the picture. The Wasukuma are in the same language group as the Wanyamwezi, who are more well-known, because they are great travellers and were connected with the first explorers. The Unyamwezi cultivation steppe to the south runs contiguous with that of Usukuma, and with the exception of a stretch of 35 miles of woodland the whole of the country due south between Mwanza and Tabora is occupied in the manner described above. The Wasukuma are renowned for their dancing societies. They do much of their work in social groups or by communal effort. They are quite energetic producers

* From *East African Annual*, 1947-48,

of cotton and rice as well as stock. They sold annually on the average in the last eight years £200,000 worth of cotton and £70,000 worth of other produce, together with 9,000 head of stock worth £190,000, and other animal products valued at £75,000. The cash return per tax payer derived from the sale of natural products is about Shs. 60/-, whilst the poll tax is now Shs. 12/- per head. There was an increase of 8 per cent. in the population between 1934 and 1944, but there is no indication of how much of this increase was from immigration. The country is capable of greater productivity, once the mistakes have been set right and new lands opened to controlled exploitation.

Discussion of the Problem

Agricultural communities depend on adequate land for improving their standard of living. The land is a fundamental necessity for any productive enterprise. Where land is overworked it must be rested and fed; where virgin land is brought into use it must be developed on a tried and tested system of agriculture suitable to the area.

Sukumaland is grossly overcrowded with humans and stock. It is suffering from severe soil erosion and deterioration of the productivity of the arable land and of the grasslands. Their productivity would diminish at an accelerated rate if the present situation were allowed to remain unaltered. This country can produce good stock and good crops if only it gets the proper treatment. Of the measures envisaged to increase the productivity per unit of effort and of land the four outlined below are the most important:—

(1) The spread of people and stock into areas at present unoccupied.
(2) The provision of many more water supplies.
(3) The speeding up, intensifying, and expanding of present methods of soil and water conservation, and manuring.
(4) The introduction of mechanical aids for cultivation and digging of water supplies.

People and stock must be spread in order to rest the over-cultivated arable, and over-grazed pastures. In the plans for rehabilitation of the land of all cultivation steppe areas, resting is necessary to solve many of the problems. It may be carried out by resting arable land and cultivating existing pasture instead, but this cannot go on for long. Most grazing land is grazed because it is unsuitable for cultivation. How else can we get land so as to rest the existing overcrowded arable? There is another way, with limited application to light land only. Cassava can replace bullrush millet and because of its high yields of starch, less land need be cultivated, and the remainder can be rested. But these are not remedies, they are but palliatives. On all sides in our attempt to improve fertility, we are baulked by inadequate land,

for the purpose of fallowing with either natural or planted grass, production of more manure, resting and conserving pasture, reserving river- and drain-sides against erosion, etc.

Admittedly, acute soil erosion in many districts has been stopped, but there is still a steady drain of nutrients from soil, already in a bad way. No new cultivation methods, no new varieties of crops, no amount of manure can give their maximum benefit unless there is enough land for resting, and resting means grass and grass means improved fertility, improved soil structure, increased food for cattle and is a soil conservation measure in itself.

It is no exaggeration to say that if the steady deterioration of our soils is not soon halted, famine will become more and more of an annual occurrence. The reason is not far to seek. As the yields per acre of grain become less, so the cultivator seeks for more land to make it up. He may first change over to cassava. Anyhow he cannot even add to this acreage after a time because of overcrowding. There are many examples in Tanganyika of how populations hold on to the land like grim death in face of famine rather than move away—the Warangi, Wajita, Wakara and the Wasukuma, for instance. The grain lands become marginal, *i.e.*, they will only just produce a modicum of grain with good rains. Whenever rain fails, yields reaped are abnormally low and shortage ensues. In other words, before overcrowding occurred, the cultivator budgeted for a surplus and almost always got enough, now he budgets for a sufficiency and often experiences a short-fall. But one must have capital to develop new industries during economic collapse, and similarly we must have spare land as our capital to build up our agricultural assets again.

Most of the Wasukuma have finally adopted static instead of shifting cultivation. They have drifted into it. They have adopted it because they are overcrowded, but static cultivation cannot be maintained under such conditions. Shifting cultivation in the true sense is wasteful of land in that it gets only nature's treatment whereas static cultivation needs less extra land for resting, because man takes part in it, but there is not enough land even for this purpose. One can take it for granted that in all but Central Usukuma, a state of saturation has been reached. All suitable light land has been taken up, so what is required for resting must come to a great extent from unsuitable soils, *i.e.*, pasture, or from existing homestead cultivation. As far as animal husbandry is concerned, the development of a system of resting arable land by grassing it down in strips will be of the greatest benefit to the cattle. To provide adequate rest care of all grass leys is axiomatic.

Provision of water will enable the people to spread if they wish. In most cases they will be able to clear their own lands of bush, leaving their cattle behind with friends until the fly has been pushed back

by their own efforts. Water often attracts the people of central and southern Usukuma who have bigger herds of cattle.

In the north and west the fields and homes of their ancestors are more attractive than new pastures and water. Water in any case is the key to the problem; though, to alleviate the position, people in certain cases will have to be ordered to move, as it is probable they will not go of their own accord.

Soil conservation methods are all-important both in the old areas and the new. Without care in the method of settlement the people will destroy the new lands as they did the old. It might be said that soil conservation cannot give a return and that it can only prevent a loss. This is true in terms of stopping the movement of soil and its fertility, but in the case of water, which is an annual gift and not an initial gift like soil, if it is held in the soil instead of going down to the valleys there is an annual gain in productivity. Tie-ridging is a method which ensures the maximum retention of water. It has been tested and demonstrated and proved successful and is now being introduced throughout the area on suitable soils. Soil must be conserved on all arable land and grazing must be protected. Water supplies must have adequate reservations of land around them. The consolidation which follows the opening up of the woodland involves every sort of conservation measure in the widest sense, ranging from the placing of the people upon the land at an optimum density and the reservation of woodland and grazing, to the insistence on the adoption of the best methods of farming. At the same time the land must not be allowed to continue to deteriorate in the overcrowded areas, thinned down as they may be. Better farming methods must be adopted, grazing land protected, destroyed grazing rehabilitated and additional small water supplies added to reduce movement of stock. Excellent returns can be obtained from applying organic manure on those soils, with consequent reduction in acreage required and work involved or alternatively greater yields.

As regards mechanical aids ox-ploughing is now to be encouraged on the heavy soils, and also transportation of manure by barrow or cart. Numerous ox-drawn dam-scoop units are being organized to dig rice ponds and domestic water supplies, earth-removing units are being attached to the Development Headquarters and a small experimental tractor-plough unit is also to be started.

It will be noted that there is no suggestion of reducing the number of stock. They are part of the farming system and, if distributed amongst a greater number of people and given new grazing ground, they are just adequate for the purpose. There would be about sixteen stock units per homestead, if the cattle were equally distributed. About half the homes own no cattle however.

The Plan

The one side of the plan is that of expansion into new land, the other of rehabilitation of the old. Let us deal with expansion first. There are at least 4,000 square miles of unoccupied land, a great part of which is suitable for occupation once water supplies have been provided. New supplies are often more necessary for stock than for humans, as existing natural supplies do sometimes suffice. A certain amount of initial clearing of bush may have to be undertaken against tsetse fly in the East, but in the West the African has already shown that he can deal with that species of fly, providing he finds water and can leave his stock behind initially. Existing staff has surveyed and prepared plans for the opening up of new areas sufficient for the next two years. Water is what is required. The best method of obtaining it is by impounding it in earth tanks (where the land is flat), in hafirs (where there is a slope and a great volume of water is not required), or in dams (where suitable valleys are available and a greater volume can be utilized). No stock or humans should travel more than three miles to water. How much water will be required, then, at each water point and how many water points per 1,000 square miles? This is where it is necessary to set out what is called "the Sukumaland agricultural equation."

In one homestead there are on the average two taxpayers or a total of seven people with an average of fourteen cattle and ten small stock units (at five small stock equalling one stock unit), equals sixteen stock units, which produce altogether sixteen tons of manure per annum. This manure is enough to manure eight acres every other year, which is one acre more than the average acreage of arable for Sukumaland, but the stock require two acres each of pasture (the average for Sukumaland is two-and-a-half acres), equals thirty-two acres plus eight of arable, equals forty acres, equals sixteen homesteads per square mile, equals 112 people per square mile, say one hundred. Three miles to walk to water is about thirty square miles, equals five hundred homesteads, equals eight thousand stock × five gallons of water × 120 days (August to November) equals 5,000,000 gallons, equals 10,000,000 gallons (to allow for evaporation) per 500 homes and thirty square miles.

From this it will be gathered that densities of humans are to be limited to a maximum of about a hundred by administrative action through the Native Authorities. African Land Bailiffs subordinate to the Federation of Native Authorities may have to be appointed to undertake this specially important work. Densities of stock can only be controlled by limiting the capacity of water supplies and increasing the area of grazing reserves and possibly limiting the number of stock to be held on the land by constant census checks. This matter has not been fully

studied as yet, but with adequate land opening up it is unlikely to be a problem. Profitable information may be gained from other provinces where local cattle rates are being successfully levied.

It may be found that a cattle rate is of value in redistributing stock as well as in providing revenue. Care will have to be taken to hold the balance between compulsory measures of proper land utilization in the old areas and the new, so that the settlements do not become unpopular owing to the stricter enforcements of these measures. The Forest Officer will be particularly interested in seeing that suitable blocks of woodland are reserved in the new lands; it will have to be ascertained how narrow they will have to be to become free from tsetse fly. They will serve as the local fuel and pole supply.

Turning to rehabilitation the problem is more difficult, although the physical work and needs of additional mechanical and man-power are not so great. As a beginning, a picture of the condition of the countryside had to be made. This could only be done adequately by the use of smaller units than chiefdoms or districts for analysing vital statistics. In order to ascertain the densities of humans and stock and to weigh up the potentialities as regards soil, water supplies and crop production, the boundaries of 750 of the 1,100 headmen's villages in Sukumaland were mapped and densities worked out. The overcrowded areas are now pin-pointed, so it is known where work should begin. Slowly but surely, populations will have to be thinned down; in some cases stock and in others humans are in excess. These emigrants will be received in the new areas, where headmen will know the maximum number of families they may receive in their villages of known capacity, with blocks of woodland and grazing reserves already demarcated. It will be difficult to decide how best to prevent overcrowding in the future as a result of natural increase, for although homesteads may be kept down to the requisite number per square mile there may be an increase in the number of people in a homestead. Improved methods leading to greater productivity should enable the land to carry more people and stock, but natural increase may finally overtake this increased productivity. That is a problem for the future.

Not all areas are overcrowded, some have suffered from past depredations and hold a modicum of people, but, owing to ignorance of the best methods of land-use, the inhabitants are unable to regenerate the land. There are also special areas where special measures must be undertaken to deal with the problem set by, perhaps, temporary over-concentration of livestock on a soil particularly susceptible to erosion. Readers will be tired of reading about the different anti-soil erosion measures. Suffice it to say that the arable is to be taken care of by tie-ridging. Already a large percentage of fields are ridged along the

contour. The pasture will have to be reserved and rested, grazed rotationally, and possibly the passage of water, with grass seeds and silt, obstructed by some form of basin or ridge.

Additional small water supplies may have to be provided to reduce the movement of livestock, or to satisfy the needs of larger numbers coming in onto the fallows and abandoned homesteads of the emigrants. This will partly fit in to the plan for digging large numbers of rice ponds of up to 500,000 gallons capacity, which will enable the rice to survive the often protracted dry period in January and February, which is often the controlling factor in rice production in these parts. A considerable sum of money has been set aside for afforestation, and it is expected that quite considerable areas of abandoned land of medium fertility will be utilized for this purpose. The diamond and gold mines will need considerable quantities of domestic fuel and possibly props in the future; it is the intention to provide for these needs in addition to the all-important one of replacing straw and manure with woodfuel, as both of these are required for the restoration of fertility. How is all this to be done? Where is the money, what is the staff and equipment, where are the headquarters and what is the political aspect?

The Organization

The germ of the plan was born in 1938 after Mr. D. W. Malcolm, District Officer (who has been actively connected with the scheme), had written a report on "Land Utilization in Usukuma," which was never published. The need was felt then for a rehabilitation plan which would know no district boundaries or departmental divisions. The idea was to have a "flying squad," who would travel over the four districts of Usukuma improving the countryside and its agriculture. £70,000 was provided for this from the Colonial Development Fund. Owing to the war it was never put into action, but the idea persisted. £450,000 has now been made available from the Tanganyika Development budget for the scheme for a period of ten years, together with £170,000 for subsidiary schemes and establishments as described later on in this section. A considerable portion of this sum is derived from the Agricultural Development Fund, to which balances from the sale of cotton (in the case of Usukuma) have been credited every year since controlled marketing began. This can be considered to be the cultivator's contribution.

A development team has been set up which has its headquarters at Malya on the Mwanza-Tabora railway line. The team is composed of the following officers: A Senior Administrative Officer as Co-ordinator, an Agricultural Officer, a Forestry Officer, and a Veterinary Officer as the technical member of the team, with an Administrative

Officer to undertake the Field Administration. The staff attached to the team will be composed of an Accountant and Storekeeper, a Mechanic, a Work Supervisor, and a Secretary at headquarters, and seven Field Officers. The team will work as a unit with a common office and equipment. It will be directed as regards broad policy and inspection of expenditure estimates by the Provincial Committee, composed of the Province Commissioner and his provincial technical advisers. Difficulties arising as between the Development team and the District teams may from time to time have to be brought to the Provincial Committee for solution. These District teams will be engaged in normal routine work together with extension of better methods to the cultivator, and at the same time certain small development works may be handed over to them to do by the Development team. They will be consulted on all development plans of the district which will be integrated in each district plan.

It may be asked what part the Native Authorities are going to take. They are the agents between the team and the people and naturally play a very important and absolutely indispensable part in the scheme. Their headquarters is also centred at Malya. It is not entirely a coincidence that the Federation of fifty chiefs of Sukumaland was set up in 1947 at a time when preparations for starting the Development team were very active, as it was appreciated both by the chiefs and the Government that both the " teams " would gain materially by union of effort, the breaking down of unnecessary barriers and the pooling of funds.

The Development headquarters is centred round a dam of 400,000,000 gallons of water, and is equipped with stores, workshops and European and African quarters. There is adequate plant for repair of machinery and building construction. Three tractors complete with soil-carrier, bulldozers, rippers and other equipment necessary for the digging of dams are on order. It is estimated that this outfit—which will be serviced by a mobile workshop and mechanic—will be able to provide three water supplies of 10,000,000 gallons capacity every year. Each supply serves about 30 square miles, so that in the ten years 1,000 square miles can be opened up by this machinery. Of the remaining 2,000 square miles of suitable available land it is hoped to open another 200 to 400 square miles by water supplies dug by hand with the assistance of small tractors for ripping the soil in preparation for removal by hand, and for consolidating the banks by rolling. The work involved in impounding water is of course much greater where the land is flat. As the *mbugas* of black cotton soil are numerous and extensive, and carry good pasture but are generally waterless, it is estimated that only 20 earth tanks sufficient for 30 square miles can be built by hand in any one year in this type of country, so the development of this type

of country may be slowed down accordingly. It is customary in Usukuma for the tribesmen to turn out in each group of chiefdoms for ten days to undertake such work with recompense in beef. This is part of the Federation contribution to the scheme. It is expected that financial support as well will be provided by the Native Treasuries in greater amounts than in the past. They are now combined in one Central Treasury. In 1947, for instance, the Native Treasury budgetted for £2,500 for capital works, and £4,000 for recurrent expenditure on soil and water conservation. The Central Treasury of the Federation hopes to provide a total of £83,000 over ten years towards development. Some afforestation, bush-clearing and soil- and water-conservation measures may have to be undertaken which can most effectively be done by tribal labour. It is not contemplated using much machinery on these works owing to the excessive cost involved. Afforestation may be an exception.

There is confidence in the plan because considerable experience has been gained by the digging of water supplies in eastern Usukuma in particular, where cultivators have flocked to the new areas. Additional confidence has been gained too by the fact that so much is based on the results of investigation at the Ukiriguru Experimental Station of the Department of Agriculture, 17 miles distant from Mwanza, and at the Lubaga and other stations. Field experiments have been undertaken at Ukiriguru, and Lubaga in Shinyanga for many years on soil fertility and soil conservation measures, and on the selection of better strains of cotton and rice and other crops. A lot is known about the value and use of organic manures on the African's fields. A system of resting under grass is being worked on also. A pernicious parasitic weed of grain crops, by name Witchweed (*Striga* spp.), which is a controlling factor in sorghum cultivation, is under investigation, though its problems really warrant some fundamental research facilities which it is hoped will be provided. The Ukiriguru station is being developed by Development Funds though it is not included in the Sukumaland scheme. Adjacent to the Experimental Station is a school for training agricultural instructors, without whom the development plan could not succeed. It accommodates 120 students. It is at the moment a territorial establishment, so only half-a-dozen instructors become available every year for Usukuma. This also is about to be provided with new buildings from Development Funds.

There are, however, two investigation centres to be attached to the Malya headquarters and staffed by the departments concerned. Inadequate information is available of afforestation methods and suitable species of trees for the area, and a forestry experimental station will be set up close by with a resident Forester. Progress has already been made with buildings at the Malya Stock Farm. Its first batch

of Boran heifers from Kenya has already arrived. Some pasture investigation will be undertaken here, particularly designed to ascertain the best means of improving permanent pasture, and also to take up the work of temporary leys where the Ukiriguru Station leaves off. The latter station experiments with grass leys for resting arable land with the emphasis on what the ley does to the arable. Malya Stock Farm will be more interested in what the arable does to the ley.

Conclusion

The main aim is the improvement of the standard of living of the African peasant, by giving him, on the one hand, new capital in the form of land, on the condition that he only lives on the interest and maintains the full capital value. On the other hand, more capital will be poured into the old lands on the same terms, to make them productive again for the 600,000 inhabitants who will probably still remain there out of the original three quarters of a million. The capital will be in the form of soil and water conservation, the improvement of fertility by manuring and resting, the reservation of pasture and the introduction of ploughing and other mechanical aids, particularly carts or wheelbarrows to transport the cattle manure. Improved seed is now available of cotton, rice and cassava from the seed stations which will assist in boosting yields, though to get the best results the fertility of fields must be improved by manuring and resting.

There need be no reduction in stock though they should be culled and redistributed. Apart from anything else they are required as manure makers and for draught purposes. Except for bigger acreages of heavy land under the plough there is no desire for greater acreage. Reliance is now placed on the improvement of yields per acre, both of grain crops and pasture grass. Much depends on how successful we are in " putting it across " to the peasantry. The Native Authorities—if they put their shoulders to the wheel—can act effectively as agents between the teams and the people, providing there is plenty of field staff to guide them. The plan is based on the development of water supplies and better methods of farming, and it is considered that it is most likely to succeed where diverse departments and Federations of Native Authorities are properly co-ordinated and funds pooled. It is an experiment in co-ordinated development. Machinery will play a bigger part than it has done in the past in native agriculture. The peasant must co-operate, else his debt to the soil will be such a burden that he will become unproductive himself. He is lucky to have new land to go into. This is his last chance. There is no more. He cries for social services. This is the only way he can get them. There is the chance for him to co-operate in this scheme. If he does not, he will learn a bitter lesson; the lesson of famine and greater poverty which the Msukuma has only just escaped this last decade.

PROSPECTS FOR WORLD RAW COTTON PRODUCTION AND CONSUMPTION IN 1948-49 —A PRELIMINARY SURVEY

BY

DUDLEY WINDEL

World stocks of raw cotton last season showed a further sharp decline from the abnormally low levels reached in 1945-46 and 1946-47 in spite of an increase of around 3,000,000 bales in world production. On the other hand world consumption continued to improve, due to the steady rehabilitation of the war-damaged textile industries in Europe and the Far East.

SUPPLY AND DISTRIBUTION OF ALL COMMERCIAL COTTON IN THE WORLD*

American in Running Bales; Other Cottons in Equivalent 478 lb. Net Bales (000's omitted)

Season	*Carryover August* 1	*Production*	*Total Supply*	*Consumption*	*Destroyed*	*Carryover July* 31
1936-37 ..	13,649	30,729	44,378	30,638	45	13,695
1937-38 ..	13,695	36,745	50,440	27,573	165	22,702
1938-39 ..	22,702	27,509	50,211	28,507	66	21,638
1939-40 ..	21,638	27,326	48,964	28,496	206	20,262
1940-41 ..	20,262	28,720	48,982	26,595	220	22,167
1941-42 ..	22,167	25,616	47,783	25,033	165	22,585
1942-43 ..	22,585	25,582	48,167	24,293	304	23,570
1943-44 ..	23,570	24,521	48,091	22,566	121	25,404
1944-45 ..	25,404	23,631	49,035	22,204	233	26,598
1945-46 ..	26,598	19,890	46,488	23,110	337	23,041
1946-47 ..	23,041	20,279	43,320	25,893	205	17,222
1947-48 ..	17,546	23,324	40,870	26,920	230	13,720
1948-49 ..	13,720	28,035	41,705	—	—	—

World production in 1948-49 promises to show a substantial further expansion, thanks very largely to a bumper U.S.A. crop and increased harvests in Egypt and Mexico. In addition, larger acreages planted in South Brazil, Argentina and Uganda point to better crops in these countries from the harvests to be gathered next spring.

On present indications, the total world production of commercial cotton this season will be around 28,000,000 bales, as against 23,324,000 bales last season and 20,279,000 bales in 1946-47. This prospective

* Source: New York Cotton Exchange to 1946-47. Writer's estimates 1947-48 and 1948-49.

out-turn, if realized, should more than suffice for world consumption, which is unlikely this season to reach last season's figure of around 26,920,000 bales.

WORLD CARRYOVER AND PRODUCTION OF COMMERCIAL COTTON IN THE WORLD*

AMERICAN IN RUNNING BALES; FOREIGN IN EQUIVALENT 478 LB. NET BALES (000'S OMITTED)

World Stocks, July 31, 1948.	
U.S.A.	3,100
Canada	150
Mexico	90
Other N. America	25
Brazil	880
Argentina	310
Peru	130
Other S. America	115
U.K.	1,360
France	340
Italy	360
Russia	500
Germany	130
Holland	90
Belgium	150
Switzerland	100
Sweden	75
Spain	110
Czechoslovakia	70
Yugoslavia	30
Poland	130
Other Continent	160
India	2,100
Pakistan	100
China	750
Japan	225
Other Asia	220
Egypt	850
Belgian Congo	100
Other Africa	390
Australia, etc.	80
Afloat	500
	13,720

World Production, 1948-49.	
U.S.A.	14,800
Mexico	570
Other N. America	40
Brazil	1,500
Argentina	400
Peru	300
Other S. America	95
Continental Europe	130
Russia	2,700
Turkey	250
Persia	120
India	2,400
Pakistan	1,000
China	800
Burma	35
Other Asia	120
Egypt	1,700
Belgian Congo	190
British East Africa	360
Nigeria	25
French Africa	100
Portuguese Africa	120
Sudan	230
Elsewhere	50
	28,035

The above statistics show that world stocks of commercial cotton on August 1 last, at 13,720,000 bales, had fallen very considerably from the 26,487,000 bales accumulated during the war period. The contraction in supplies was particularly marked in the U.S.A., Brazil, India, Pakistan and Egypt, and resulted partly from reduced production, but mainly from the heavy post-war distribution to rebuild stocks in European countries, China and Japan.

* Tentative Estimates.

Fortunately from the world supply point of view, last season's strong upward movement in cotton prices, coupled with more abundant food crops, has resulted in increased cotton acreages this year in the U.S.A., Egypt, Brazil, Argentina, Mexico, Uganda and a number of minor producing countries. Prospects for the harvests are also generally favourable and are tentatively summarized below.

North America

United States.—Acreage planted to cotton last spring was 23,253,000 acres, as against 21,500,000 acres in the previous season—an increase of nearly 10 per cent. The growing season has been almost ideal and acreage abandonment has consequently been much smaller than usual. The average yield per acre at over 312 lb. is an all-time record, giving an indicated production of about 14,800,000 running bales, as against a final out-turn of 11,571,000 bales last season.

Mexico.—Acreage planted to cotton this year is estimated at between 6 and 10 per cent. larger than last season. Good growing conditions resulted in improved yields and a harvest of around 570,000 bales is expected compared with 490,000 bales in 1947-48.

South America

Brazil.—Acreage sown to cotton in the Northern States last spring is believed to have been 10 per cent. larger than in 1947. Excessive rains in the summer, however, marred the harvest prospect and it is doubtful if the final yield will reach 450,000 running bales.

In São Paulo, the high prices obtained from the 1947-48 crop and the poor returns farmers obtained from the growing of pea nuts have stimulated a much keener demand for cottonseed this autumn and it is expected that the planted acreage is 30-35 per cent. larger. Under normal growing conditions the 1948-49 South Brazil crop should exceed 1,000,000 running bales, as against the 780,000 running bales harvested in 1947-48. Very little of last season's crop still remains unmarketed.

Peru.—The 1947-48 growing season was disappointing and insect damage reduced the final out-turn to around 280,000 bales (478 lb. net). Only a small amount of lower grade cotton now remains unsold. Acreage planted to cotton in the various valleys this autumn is believed to be somewhat larger than a year ago.

Argentina.—Last season's harvest at around 400,000 bales was moderately better quantitatively than the poor out-turns of the previous two seasons, but the quality of the crop was poor owing to excessive rains and frosts at picking time. With production barely sufficient to cover the needs of the domestic mills, the Government was forced to maintain a ban on raw cotton exports. Acreage planted to the new crop this

autumn is estimated at 5-10 per cent. larger than last year, and good rains have given the crop a favourable start.

Africa

Egypt.—Acreage planted to cotton last spring is officially estimated at 1,440,809 feddans, as against 1,254,154 feddans in 1947. The growing period has been normally satisfactory and the final yield is expected to reach 8,196,550 cantars (1,127,000 running bales), as against 6,290,000 cantars (865,195 running bales) last season.

As a result of the heavy export movement last season, stocks in Egypt declined from 5,788,000 cantars (796,144 running bales) on August 31, 1947, to 3,066,000 cantars (420,970 running bales) on August 31, 1948.

Sudan.—Acreage planted this autumn in the irrigated Sakel areas is reported to be approximately the same as in 1947, but a considerable increase has taken place in the American-seed rain-grown districts. Crop accounts to date are favourable except in the Tokar area, where water supplies have been deficient. The prospective harvest should be at least equal to the 1947-48 out-turn of 1,039,959 cantars (approximately 260,000 running bales).

British East Africa.—Acreage under cotton in Uganda this season is about 50 per cent. larger than in 1947-48. Growing conditions to date have been considerably better and the harvest is expected to reach 350,000 bales, or more than double last season's out-turn. The 1948 Tanganyika crop at around 50,000 bales (400 lb.) fully equalled the average for previous seasons.

Belgian Congo.—The area sown to cotton this season is reported to be little changed from that for the previous season, and the 1948-49 crop is estimated at around 40,000 tons or approximately 190,000 bales (478 lb. net).

French Colonial Africa.—The 1948-49 crop is estimated at around 22,000 tons, or close to 100,000 bales (478 lb. net).

Portuguese Colonial Africa.—The combined Angola-Mozambique crop for the present season is expected to at least equal the 1947-48 out-turn of 27,000 tons of lint (about 120,000 bales of 478 lb. net).

British West Africa.—Acreage planted to cotton this year was considerably larger than in 1947 as a result of the rise in prices. It is doubtful, however, if the exportable surplus will exceed 20,000 bales (400 lb.) owing to the keen demand for cotton from the native hand-spinning industry.

Europe

Continent.—Total cotton production in Spain, Italy, Bulgaria, Greece and Roumania registered a further improvement this season. Lack of foreign exchange, high prices and some easing in the food situation are factors encouraging an increase in cotton growing.

ASIA

Russia.—No official statistics are available of acreage planted to cotton or of the harvests gathered. According to the Soviet Press, the cotton acreage increased 6-7 per cent. in 1948-49, but yields have not come up to expectations, and the final out-turn is not expected to be much larger than the 1947-48 estimated figure of 2,600,000 bales (478 lb. net).

Turkey.—Acreage under cotton this year was moderately increased, but unfavourable weather and insect damage reduced the yield to around 240,000 bales (478 lb. net) or only slightly more than the 1947 crop.

India.—Acreage sown to cotton in the Indian Union this season is believed to have been slightly larger than last season, but owing to the irregularity of the Monsoon it is doubtful if the harvest will exceed the 1947-48 out-turn of 2,750,000 running bales. Domestic mill requirements of East Indian cotton this season on the basis of the present rate of activity will exceed 3,700,000 bales. The deficiency will be partly made good by imports of up to 650,000 bales from Pakistan.

Pakistan.—Acreage under cotton this year is about the same as in 1947, but the growing season has been more favourable and harvesting has not been disrupted by serious communal troubles. Production is estimated at around 1,300,000 running bales—or 15 per cent. more than last season. It is hoped to export about 1,200,000 bales.

China.—The 1948 growing season was generally favourable and more land was sown to cotton in 1947. The estimated harvest is around 2,800,000 bales (478 lb. net), as against 2,200,000 bales last season. Unfortunately, the over-running of North China by the Communist military forces and the chaotic economic state of the country threaten to paralyse the movement of cotton from the interior to the Shanghai and other mills. Consequently it is highly problematical if more than a few hundred thousand bales of the current crop will become available for commercial consumption.

WORLD CONSUMPTION OF RAW COTTON

In face of the present very uncertain international political and economic outlook it is not possible to make more than a highly tentative estimate of world consumption of commercial cotton during the present season.

During the late war period, world consumption declined from around 28,000,000 bales annually to below 22,500,000 bales annually. Since hostilities ceased in 1945, consumption has steadily recovered, and last season almost 27,000,000 bales were spun into yarn by the world's mills. Compared with 1938-39, consumption in Japan, Germany, Russia and the United Kingdom is still well below, but these deficiencies have been largely made good by increased consumption in the U.S.A., India,

Canada and the South American countries. Moreover, world rayon production has increased from around 1,924,000 lb. in 1938 to over 2,100,000 lb. in 1948.

CONSUMPTION OF COMMERCIAL COTTON IN THE WORLD

AMERICAN IN RUNNING BALES; FOREIGN IN EQUIVALENT 478 LB. NET BALES (000's OMITTED)

	1947-48*	1948-49†
U.S.A.	9,350	8,500
Canada	365	375
Mexico	275	270
Other N. America	60	70
U.K.	1,935	2,100
France	1,100	1,000
Germany (all zones)	580	750
Italy	700	700
Belgium	420	380
Czechoslovakia	250	230
Holland	220	250
Poland	330	350
Spain	325	325
Switzerland	145	145
Portugal	135	130
Sweden	120	120
Hungary	125	130
Greece	45	30
Other Europe	390	400
Russia	2,300	2,300
India	3,400	3,700
Pakistan	100	125
Japan	600	800
China	1,600	1,200
Other Asia	470	450
Brazil	850	800
Argentina	370	400
Peru	60	70
Other S. America	230	250
Australia, etc.	70	100
	26,920	26,450

Consumption in the U.S.A. this season looks like declining further, partly as a result of the completion of wholesale and retail re-stocking in the domestic market and partly owing to the marked falling off in textile exports. U.K. consumption should be moderately larger than last season, but no important change appears probable on the European Continent. India and Japan may be expected to register some improvement, but any consumption gains in these two countries appears likely to be offset by a decrease in China.

On present prospects, it is doubtful if world consumption this season will reach 26,450,000 bales, as against 26,920,000 bales last season, and an increase of over 1,000,000 bales in the world carry-over at the end of next July appears to be indicated.

* Revised. † Tentative estimates.

REVIEWS

Comptes Rendus de la Semaine Agricole de Yangambi. (Institut National pour l'Étude Agronomique du Congo Belge. 2 vols. Brussels. 1947. 250 frs.) The main theme of this inter-African Agricultural Conference, the maintenance of fertility in Central African soils under cultivation, is discussed in our editorial, and the papers having specific reference to cotton are included under the appropriate classification in the abstracts. It remains to indicate the general scope of this publication, which in its 110 communications covers an exceedingly wide field and has great interest as a record of experience gained and conclusions reached in the scientific study of colonial agriculture and forestry.

The papers presented to the Conference are grouped under nine sections: (1) Methods of cultivation and the protection of the soil; (2) Native agriculture and food crops; (3) The major industrial cultures; (4) Fibre plants; (5) Studies of soil and of climate; (6) Agricultural phytopathology and entomology; (7) Agricultural technology; (8) Economic and social questions; (9) Matters concerning forestry. Under each of these headings there are papers on subjects so diverse as to defy any attempt at a summary; the whole constitutes a unique collection of studies in tropical agriculture in the widest sense.

Trente Années de Culture Cotonnière au Congo Belge, 1918-48. This handsome volume of 140 pages, profusely illustrated, is issued by the *Compagnie Cotonnière Congolaise* in commemoration of the twenty-fifth anniversary of its foundation in 1920 on the initiative of the Minister for the Colonies at that time. Delays in production have enabled the period covered to be extended and recent fundamental changes to be recorded. The work is a contribution to the history of agriculture in the Congo and provides a most useful account of the organization and progress of the cotton industry in the Colony.

Tentative and inconclusive trials of cotton cultivation were made in the early years of the century, but it was not until after the first world war that proposals were put forward for a serious effort. These met with much scepticism and opposition, and it would appear that it was the interest and influence of King Albert which turned the scale. The *Compagnie Cotonnière Congolaise* (Cotonco) was constituted in 1920 with a capital, obtained with much difficulty, of 6,000,000 francs. The capital had risen to 60,000,000 by 1929 and is now 300,000,000. The production of seed-cotton in the Colony was 1,527 tons in 1920 and 122,734 tons in 1946. There are two large regions of production: one extending from the northern boundary southwards to the neighbourhood of the great river, making contact with it at Stanleyville; the other, in the south-east quarter, roughly opposite Lake Tanganyika. Ecological conditions are divided: characteristic of forest country on the one hand, savannah on the other.

The formation of Cotonco and the issue in 1921 of a decree defining the conditions governing the development of the industry were followed in

the next year or two by a headlong cotton "rush," and as an outcome some twelve companies now operate. The system of development by recognized companies, involving local monopolies of purchase and ginning with an obligation to purchase at a price fixed by the government, is claimed, in spite of criticism, to be the one best suited to the circumstances of a primitive country. The defects of the system of relatively free enterprise in the British colonies, it is pointed out—the over-provision of ginneries, the abuses of middlemen, and the irregular fluctuations in the price paid to the grower—have all been successfully avoided. To these might have been added the obvious benefits of overall control of the standards of ginning and grading, the absence of which is a matter of current concern to users of East African cottons. The system has been copied in French Equatorial Africa and in the Portuguese African colonies.

The Cotton Companies regard themselves as having wider responsibilities than the purely commercial ones of buying, processing, and selling cotton. They co-operate with the National Institute of Agronomy in the Belgian Congo in scientific investigations, and supplement at considerable expense the social services which are primarily the concern of the Government, subsidizing for this purpose the various agencies, missionary and medical, occupied with the well-being of the natives.

Under the decree of 1921 the price-fixing formula finally arrived at allotted to the growers 85 per cent. of the profit, the remaining 15 per cent. going to the Companies concerned. In recent years a proportion has been diverted, in the interests of stability, to a reserve fund, from which grants are made from time to time for works directly beneficial to the growers. The prices actually credited to growers, apart from this, in 1945 and 1946 varied, in English terms, from roughly 3d. to 5d. per lb. of lint according to region. In 1947 the sum directly paid to the growers amounted to 300,000,000 francs (£1,714,000), and a further 180,000,000 (£1,028,000) were deposited in the reserve fund. The total value of the crop in that year exceeded 656,000,000 francs (£3,748,000).

Influenced by views expressed at international conferences, the Department of the Colonies recently decided to discontinue the system of monopoly buying and to arrange for the growers to receive the whole proceeds of the sale of their produce. A new decree with these objects in view was issued in 1947. Under the new scheme the cotton is to remain the property of the grower, and is remitted for the purposes of ginning, transport and sale to a co-operative society functioning under government supervision. This society contracts with the owner of the regional ginnery for the treatment of the crop, on conditions approved by the Governor. The rôle of the *Sociétés Cotonnières* is thus reduced to the processing of material no longer their property and its transport to the port of shipment, where it is delivered to a central organization for sale on behalf of the producers.

Such a radical change of policy must necessarily involve great practical difficulties in transition, and in default of adequate preparation, of which there is no suggestion, its realization must throw an immense strain on the officials charged with its supervision. The primitive African has an instinct for communal action in his accustomed sphere, but attempts elsewhere to develop from this a sense of business responsibility have seldom been conspicuously successful.

Another, quite unrelated, change is in process of realization. Up to the year 1943, 90 per cent. of the cotton cultivated in the Congo was of one variety, Big Boll Triumph, originating from the U.S.A. Only in Kivu, a somewhat remote and isolated area, was another variety grown, the U.4 derivative 998 received from Morogoro. In recent years there have been introduced into the North the variety Stoneville (U.S.A.), into the South the cotton GAR, a cross between U.4 and Triumph, and in Kivu 14-125, a selection from 998. These are intended to displace the varieties previously grown, and are expected to provide a marked increase in yield.

An account of the ginneries maintained by Cotonco indicates that every effort has been made to provide good equipment and to keep it up to date. The latest, erected a short time before the war, has a capacity, for the season, of 5,000 tons. It is claimed to be inferior in no respect to the most modern American installations, whether from the point of view of production or of the quality of the out-turn.

There exist in the colony three oil factories, with a combined capacity approaching 25,000 tons out of some 70,000 tons in the total crop; new factories are in course of realization which will bring the figure up to 50,000. In view of the progress made in methods of purification, the time is regarded as not far distant when cotton-seed meal will provide an important article of food for the African population, especially suitable with its high protein content to balance the excessive consumption of starchy foods in the present diet.

An institution which developed from the need for co-ordination among the twelve cotton companies, operating between them 124 ginneries, is the *Comité Cotonnier Congolais*, founded in Brussels in 1929. This body has enabled combined action to be taken by the industry in times of crisis, is in a position to negotiate in its interests with the administration, and co-operates with I.N.E.A.C. on scientific investigations which concern it. The Committee has operated a selling pool and has been largely concerned in maintaining the uniformity and the high standards of preparation which have given Congo cotton its reputation in the markets.

It will be appreciated from this outline that the volume presents, from the point of view of one of its principal agents, an account of closely organized development, remarkably successful in its commercial aspect. There are other aspects to be considered: one of them, the serious concern which has arisen as to the maintenance of fertility, is discussed elsewhere in this issue. It would also be exceedingly interesting to know what effect the development of the industry has had on the social and political economy of the native communities. This is an appropriate time for these matters to be considered, since it is evident that the book is more than a progress report, it is the history of a system which has, for better or worse, come to its end.

Le Raffinage de l'Huile de Coton. M. Pilette. (Issued by the Compagnie Cotonnière Congolais. Brussels. 1948. Pp. 255.) This is a highly technical publication dealing with the theory and practice of the refining of cottonseed oil, and follows the issue in 1942 of a work by

the same author, "L'Extraction de l'Huile de Coton aux États-Unis." The work has been prepared with a view to furthering the marked development of the cotton-seed oil industry in the Belgian Congo which took place during the recent war. As a book it is exceedingly well produced and clearly illustrated, and would appear to be correspondingly thorough in its treatment of the subject.

NOTES ON CURRENT LITERATURE

COTTON IN INDIA AND IN PAKISTAN

1. A HUNDRED YEARS OF INDIAN COTTON. By M. L. Dantwala. (The East Ind. Cott. Assen., Bombay, 1947.) In this Souvenir Volume the author reviews the history of cotton and of textiles in India during the past hundred years. The headings of the various chapters are as follows: I. Grow more cotton; II. Cotton sales abroad; III. Early transport and legislation; IV. Marketing then and now; V. Cotton merchants gather; VI. The East India Cotton Association; VII. Future trading; VIII. The Gateway of cotton; IX. Looking ahead. The volume is well furnished with illustrations and diagrams, several of which are coloured, and 70 references to the literature on the subject are also included.

2. THIRD CONFERENCE ON COTTON GROWING PROBLEMS IN INDIA, 1946. (Ind. Cent. Cott. Comm., 1947. Price Rs. 4. Received 1948.) The Conference was held on February 4 and 5, 1946. A full report is given of the papers read and discussed by those present. The subjects dealt with included various aspects of cotton breeding and genetics, cotton technology, and the pests and diseases of cotton. Several of the papers are abstracted elsewhere in this Review.

3. INDIAN CENTRAL COTTON COMMITTEE: ITS PAST PERFORMANCE AND FUTURE NEEDS. By R. G. Saraiya. (*Ind. Cott. Gr. Rev.*, ii, 2, 1948, p. 47.) A brief account is given of the benefits which have been derived from the work carried out on cotton by the Committee since its inception twenty-six years ago. The following are among the successes achieved: The evolution and spread, with the co-operation of the Departments of Agriculture, Bombay and Baroda, of Vijaya cotton for the Broach tract and for Baroda State; the replacement of Oomra desi cotton by Jarila; the evolution of the improved Suyog cotton for the Surat tract, and excellent cottons for the Punjab such as 289F/43, 124F, and 199F. In the past the Committee's work has mainly centred round the problem of breeding superior varieties for replacing unselected local types. Future work will need to be planned on a more comprehensive basis and the agronomic aspect emphasized, since, in addition to the evolution of improved varieties for tracts as yet undeveloped, a major problem to be tackled is the increase in yield per acre. To solve this problem successfully intensive research in manuring, crop rotation, soil science, and physiology will be required. At a meeting held in November, 1947, it was unanimously agreed that if the objects in view were to be achieved effectively and in the least possible time, the Committee's past method of approach towards the solution of cotton problems required to be radically reorientated. Accordingly a proposal was approved for the establishment of a regional cotton research station, fully staffed and equipped, for each of the ecological cotton tracts of the country, for the purpose of solving the various cotton problems. Government is to be asked to sanction additional funds of the order of Rs. 25 lakhs to be placed at the disposal of the Committee to enable it to enlarge the scope of its work.

4. SPINNING TEST REPORTS ON INDIAN COTTONS, 1946-47. By D. L. Sen. (*Tech. Circs.*, Nos. 705-709, 713-722, 724-732. Ind. Cent. Cott. Comm., 1947.) The circulars contain the grader's report and spinning test results for Bawla, 1931-46 seasons; Bijapur, 1937-47 seasons; Broach B.C.8, 1944-47 seasons; Cambodia Co. 2 (Avanashi), 1945-47 seasons; Cambodia Co. 2 (Dharapuram), 1945-47; Cambodia Co. 4 (Ramnad District), 1945-47 seasons; C.P. No. 1, 1940-48 seasons; Farm Westerns (Bellary), 1939-47; Gaorani 6, 1944-48 seasons; Jayawant (Bailhongal), 1944-47 seasons; Jayawant (Hubli), 1942-47 seasons; Karunganni (Coimbatire), 1941-47 seasons; L.S.S. (Lyallpur), 1939-47 seasons; Malvi, 1944-48 seasons; Navsari,

1940-47 seasons; P.A. 4F. (Bahawalpur), 1944-47 seasons; P.A. 4F. (Jhang), 1945-47 seasons; Punjab-American 4F. (Montgomery), 1935-47 seasons; Sind Sudhar, 1940-47 seasons; Surat, 1942-47 seasons; Suyog (Seg. 8-1), 1945-48 seasons; Upland gadag, 1937-47 seasons; Vijay, 1945-47 seasons; Wagad (Viramgam), 1944-47 seasons.

5. TECHNOLOGICAL REPORTS ON INDIAN COTTONS, 1946-47. By D. L. Sen. (*Tech. Circs. Nos.* 704, 710-712, 723. Ind. Cent. Cott. Comm., 1947.) The particulars given include agricultural details, grader's report, fibre particulars, spinning test results, remarks.

Gaorani 6.—The 1946-47 sample is somewhat shorter than that of last year; all its other fibre properties are practically the same. Suitable for 30's warp.

Jayawant (*Kumpta*).—The 1946-47 sample resembles its immediate predecessor practically in all respects. Suitable for 32's warp.

Punjab-American 4F.—The 1946-47 sample is more regular in length, and has lower fibre weight per inch and higher fibre strength than its immediate predecessor. It also contains a lower percentage of mature fibres. Suitable for 26's warp.

Surat 1027.—The 1946-47 sample contains a lower percentage of mature fibres than last year's sample, but is smaller in other respects. Suitable for 35's warp.

*V.*434 (*Akola*).—The 1946-47 sample is slightly weaker than its predecessor. Suitable for 24's warp.

6. VARIATION IN GINNING OUTTURN BROUGHT ABOUT BY CHANGES IN AGRONOMIC TREATMENT. By Mohammad Afzal. See Abstract 58.

7. INHERITANCE OF FUSARIUM-RESISTANCE IN INDIAN COTTONS. By S. G. Kelkar *et al.* See Abstract 87.

8. A REVIEW OF CHROMOSOME CONJUGATION IN ALLOTETRAPLOID COTTONS. By N. K. Iyengar. See Abstract 96.

9. SOME CONSIDERATION OF INTERSPECIFIC HYBRIDS AND POLYPLOIDS IN COTTON. By G. B. Patel. See Abstract 95.

10. THE PREDICTION OF SPINNING VALUE OF GAORANI (BANI) COTTONS. By P. D. Gadkari and Nazir Ahmad. See Abstract 114.

11. INDORE INSTITUTE OF PLANT INDUSTRY: PROGRESS REPORT, 1946-47. The Institute was reorganized in June, 1946, but financial difficulties made it impossible to expand its activities to the desired extent. The Cotton Genetics Research Scheme has been entrusted to the Botany Section, and efforts are being made to evolve new strains of cotton suitable for the Malwa and Nimar tracts of Central India. The results of the experiments on this work so far carried out are briefly summarized.

No programme for genetic work on cotton has been submitted for the season reviewed, but experiments were continued on problems on which investigations were already in progress—namely, boll locular composition, chlorophyll deficiency, jassid resistance, and seed weight. Experiments were also continued on inter-specific hybridization and vernalization, and on the manuring of cotton. The proposed plant-breeding programme for 1947-48 is appended.

12. AMERICAN COTTONS: THEIR CULTIVATION AND BREEDING IN MYSORE. By L. S. Dorasami and G. S. Iyengar. (*Ind. Cott. Gr. Rev.*, ii, 1, 1948, p. 9.) The cultivation of varieties of American cotton in Mysore and the evolution of types resistant to disease were commenced in 1919. The strains M.A. I, M.A. II, and M.A. IV were developed from a cross between local Doddahatti (Dharwar American) cotton and *Gossypium purpurascens*. M.A. II was the most successful of these strains, being resistant to red leaf disease, and giving better yield, staple, and ginning percentage than the local variety, though it did not compare favourably with the standard American cottons. Further breeding work has been carried out since 1936 under a scheme financed by the Indian Central Cotton Committee, to evolve improved red leaf resistant varieties. Selection from the acclimatized exotic cottons such as 289F/38 and their reciprocals have yielded several good strains, of which M.A. V and M.A. VI are the best. X-ray treatment has been investigated,

and a new drought-resistant strain, M.A. IX, has been produced by such treatment of Co. 2. The strain will prove useful for cultivation in areas of poor rainfall. Experiments conducted to test the performance of Co. 4, M.A. V, and other strains, with different dates of sowing and in irrigated and rain-fed areas, indicated that M.A. V was definitely superior to Co. 4, M.A. II, and other local cottons.

13. PROBLEMS IN COTTON IMPROVEMENT IN THE PUNJAB. III. IMPROVEMENT IN GINNING OUTTURN AND STAPLE LENGTH. By M. Afzal. (*Ind. Cott. Gr. Rev.*, ii, 2, 1948, p. 73.) Statistics are included of the following: Frequency arrays of ginning percentage before and after selection; ginning percentage of reselections in 289F/43; different staple-lengths produced on All-India basis (in thousand bales of 400 lb.) yield of Jubilee strains as compared to 39-Mollisoni; ginning outturn, spinning counts and cash return per acre of Jubilee strains; yield, technological properties and acre cash-value of Jubilee-*anomalum* derivatives; consumption of middling and superior yarn.

14. INVESTIGATIONS ON THE RED LEAF DISEASE IN AMERICAN COTTONS: I. RED LEAF DISEASE IN SIND-AMERICAN COTTONS IN SIND. By R. H. Dastur and Kanwar Singh. See Abstract 85.

COTTON IN THE EMPIRE

15. AFRICA. COTTON PRODUCTION IN BRITISH EAST AFRICA. (*Times Ref. Ind.*, 2, May, 1948, p. 63. From *J. Text. Inst.*, xxxix, 6, 1948, p. A287.) The consensus of opinion is that British East Africa offers the opportunity of a substantial increase in cotton production in the immediate future. The pre-war output of 500,000 bales seems capable of being doubled. It is pointed out that the problem of raising East African cotton production depends to a large extent on the native cultivator, and furthermore that large expansion of cotton growing must presuppose a guaranteed market for the expanded crop.

16. NIGERIA: COTTON PROSPECTS, 1948. (*Cott. and Genl. Econ. Rev.*, 22/10/48.) Rainfall in the Northern belt has generally been above the average, with exceptionally heavy rainfall in Katsina and Sokoto Provinces. Acreage planted is considerably in excess of 1947, especially in the main cotton belt. There should be a good crop, but final yields are dependent on favourable growing conditions during October. Given these conditions, an export crop of some 30,000 bales might be expected, but it should be emphasized that this will depend largely on the amount of cotton absorbed by the local trade.

As regards the Southern Provinces, in Oyo Province, 27,769 lb. of Ishan seed were distributed, as against 12,995 lb. in Abeokuta Province. It is difficult to estimate the area planted with farmers' own seed, but it is probably about the same as that of last year. Distribution in Abeokuta Province was poor on account of lack of rain during the planting season.

17. ECONOMIC ASPECTS OF THE COTTON INDUSTRY OF NORTHERN NIGERIA. By R. Turner. (*Emp. J. of Exp. Agric.*, xvi, 63, 1948, p. 178.) An interesting report is given of the cotton industry and factors affecting production. The subjects of price and the effect of other crops on the industry are discussed, together with those of marketing, ginning, and transport. The author pays tribute to the assistance given by the Empire Cotton Growing Corporation and the British Cotton Growing Association in establishing the industry.

18. NYASALAND: COTTON PROSPECTS, 1948. (*Cott. and Genl. Econ. Rev.*, 5/11/48.) The report of the Department of Agriculture states that marketing continues on the Lower River, but elsewhere in the Protectorate, with the exception of Karonga, buying has now come to an end. In the Blantyre and Fort Johnson districts 363½ short tons of seed cotton were purchased out of an estimated crop of 367, but in the Central Province only 222 short tons reached the markets out of an estimate of 425. There is no reason to doubt that the estimate was correct, and it is not believed that any appreciable amount remains unsold in the hands of the native producers. On the

Lower River, 4,464 short tons of seed cotton have been purchased out of an estimated crop of 6,656 tons. The quality of the later pickings has deteriorated, due mainly to the damp conditions during the month, which stimulated growth and encouraged stainer attack.

19. SUDAN: COTTON RESEARCH, 1946-47. (*Summary of Rpt. of Res. Div., Dpt. Agr. and For.*, 1946-47. Received 1948.) *Sakel Cotton.*—Spinning tests have shown that the blackarm resistant X1730A types of Sakel Egyptian cotton—viz., BAR 1730L, BAR 4/5, and BAR 4/11—are equal to X1730A. In seed cotton yield none of the BAR strains equalled the main crop yield of X1730A; in lint yield BAR 1730L and a selection of BAR 1730 were nearest to X1730A, with BAR 4/5 and BAR 4/11 falling away owing to poorer ginning outturn. In sowing date trials BAR 4/11 yielded 7 per cent. less than X1730A at the Gezira Research Farm.

Production of blackarm resistant Domains Sakel was continued at Shambat by transferring the genes B_1, B_2 and B_3 from blackarm resistant NT2 to Domains Sakel Selection 1. A fourth gene B_4 and a major resistance gene in Grenadines White Pollen cotton were also studied. Progress was made in the bulk selection of Domains Sakel for resistance to leafcurl disease, and backcrossing of blackarm resistant Domains Sakel to the leafcurl resistant parent has commenced at Shambat. In view of the serious damage caused by jassid in the Northern Gezira and some White Nile Schemes, much importance is attached to the production of resistant Sakel cottons by transference of major genes for hairiness from a number of other types. Several wild cottons are almost immune to both pink and Egyptian bollworms, and transferences of this resistance from *G. thurberi* and *G. armourianum* to New World cottons have reached the second backcross stage and appear very promising. Hexaploid parents were used in the first stage of the transference.

Rain-grown Cotton.—At Shambat breeding work was carried out on BAR SP84 and BAR BP52, the latter particularly for Uganda. The bollworm resistant artificial hexaploid *G. armadense* was crossed with, and backcrossed to, XA129. In Kordofan, BAR SP84 was selected, following its success in all varietal trials in the previous season in Kordofan and Equatoria; special attention was given to robustness and vigour to withstand the vagaries of the Kordofan climate. A new variety, MU8B ex-Tanganyika (originally ex-India) outyielded all other varieties, including BAR SP84, in Equatoria. At Kadugli, injury to cotton was caused by stainers and pink bollworm. Fleabeetle was successfully controlled by DDT and leafroller by hand-picking. In Equatoria, *Helopeltis* caused more damage than for many years.

20. THE WILD COTTONS OF DJEBEL-MARKHAYAT (ANGLO-EGYPTIAN SUDAN). By G. Roberty. (In French. *Bull Soc. Bot. Fr.*, **93**, 1946, p. 39. From *Pl. Bre. Abs.*, xviii, 2, 1948, p. 327.) Two *Gossypium* spp., *G. anomalum* and *G. somaliense*, are stated to grow on the high plateau of Djebel Markhayat. There is no sign of hybridization between them. The author is of the opinion that *G. somaliense* should, perhaps, be excluded from the genus *Gossypium* because of its united stigmas. The two species are described. They have been crossed, artificially, with several other species at Shambat, near Khartoum.

21. GEZIRA. (*Cr. Col.*, October, 1948, p. 581.) Cotton profits payable to tenants amounted to £E2,440,000. Half the amount was due to be paid in August, and one-sixth each in September, November, and April.

22. TANGANYIKA: COTTON PROSPECTS, 1947-48. (*E. Afr. and Rhod.*, 28/10/48, p. 239.) It is expected that the most optimistic estimates of the cotton crop in the Mwanza area will be realized. By the middle of September seed cotton equivalent to over 42,000 bales had already been purchased, and a further 2,500 bales are expected. This will constitute the best crop harvested since 1941, which was the record year.

23. COTTON PROSPECTS, 1948-49. A report from the Department of Agriculture for September is to the effect that in the Eastern Province picking is now general in all areas, and prospects of a fair crop are assured. Because of a very small "top" crop the estimate has been reduced to 6,000 bales. The percentage of first quality cotton appears to be much higher than usual and natives are taking more interest

in the crop. In the Lake Province purchases at the end of the month amounted to approximately 45,000 bales, with sales almost over except on Ukerewe Island. In the Tanga and Northern Provinces picking has started in the Handeni and Korogwe areas of an excellent crop which will yield much in excess of previous seasons. The Moshi crop is, however, described as only fair. Estimates are not available at the time of writing.

24. UGANDA. (Dept. of Agric. Ref., October, 1948. From *Cott. and Genl. Econ. Rev.*, 29/10/48.) Acreage planted to cotton to end of September amounted to 1,528,897 acres. During September rainfall tended to be excessive in most areas, but, in general, weather conditions were favourable for the greater part of the crop. There was some reduction in *Lygus* damage, but in certain areas crop prospects have deteriorated as a result of heavy damage. Blackarm damage continues and is locally severe, but no widespread heavy damage from this disease has been reported.

25. COTTON GINNERY. (*Crown Col.*, November, 1948, p. 642.) It is proposed that a portion of the £180,000 grant to the Buganda Government from the Cotton and Hard Coffee Control Funds shall be used by that Government to finance the acquisition of a ginnery to be operated by an approved group or association of Africans. The Governor has signified his approval of the principle underlying the proposal.

26. AUSTRALIA. THE AUSTRALIAN COTTON TEXTILE INDUSTRY. By C. H. McFadyen. (*Text. Inst. J.*, xxxix, 7, 1948, p. 319.) The author draws attention to the steady development of the influence of cotton on the nation's manufacturing progress. He quotes statistics for the amount of home produced and imported cotton, and gives the history of the spinning and weaving industry from 1923 when it was started by Mr. F. M. Keighley at Newtown, New South Wales. Government legislation, originally introduced to assist the industry through the world depression, enabled it to expand and become firmly established, so that by 1939 Australia was producing 11,692,159 lb. of cotton yarn.

27. COTTON TEXTILES. (*Text. Rec.*, September, 1948, p. 78.) Total requirements of Australia are estimated at 240 million sq. yds., of which Australian mills, working one shift, could produce 40,000,000 yds., but owing to labour shortages total plant is only working at 60 per cent. of capacity. Australian manufacturers produce mainly the coarser type of cloth, so that most of the requirements for finer cloths for shirtings, poplins and dress materials come from overseas. There is sufficient plant in Australia to cover requirements in towelling, cotton tweeds, canvas and duck. Plant is available to produce 15 per cent. of local requirements in sheeting and pillow cloth, but is below full capacity due to labour shortages. Cotton yarn production at present plant (200,000 spindles) can cope with most of the local demand for coarser yarns, but during the next 18 months a further 50-100,000 spindles will be installed.

28. WEST INDIES. THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD. In the report for the year ended December 31, 1947, the Principal discusses, among other matters, the changes in the staff and the terms of service; the placing of the College finances on a satisfactory basis; approval by the Colonial Office of the research schemes for sugar, bananas, cocoa and soils, and the provision for and accommodation of the necessary scientific staff. Reports are also included by the Heads of the Departments of Agriculture, Botany, Chemistry and Soil Science, Entomology, Mycology, and Sugar Technology. Eight Diplomas of the Imperial College of Tropical Agriculture were awarded during the year, all in General Agriculture, and eight Associateships were also awarded. The number of students in residence at the end of the first term of the academic year 1947-48 was 51. During the period under review 37 scientific papers were published, and the following additions were made to the library: parts of periodicals, 6,297; pamphlets, 3,249; books, 247. The publication of the monthly journal *Tropical Agriculture* was again delayed by continued difficulties of production, and it has been found necessary as a temporary measure to issue the journal quarterly.

COTTON IN THE U.S.A.

29. MOVEMENT TO SECURE COTTON GROWERS' APPROVAL FOR COTTON QUOTAS IN 1950. (*Cotton*, M/c., 6/11/48.) Reports from the United States state that with marketing quotas for cotton a virtual certainty in 1950, the Department of Agriculture has initiated a move to secure the approval of cotton producers throughout the country to proposed changes in the Agricultural Adjustment Act governing future acreage allotments. Meanwhile, the Department was warned that cotton growers will substantially increase their cotton acreage in 1949 in anticipation of the 1950 controls, hoping as a result to secure larger allotments when acreage quotas are imposed. The Chief of Department's cotton division states that in December a conference will be held in Washington at which all proposals and suggestions will be considered. No specific recommendations for changes in the law will be drafted by the Department until the views of the growers submitted at that meeting have been carefully studied.

30. AMERICAN COTTON MILLS: ORGANIZATION ON SHIFT SYSTEM. By H. Marsden. (*Text. Weekly*, **41**, 1948, pp. 928 and 978. From *Summ. Curr. Lit.*, xxviii, **13**, 1948, p. 306.) A report of an address on impressions gained in the United States about the spreading of overhead costs by shift working and the use of larger yarn packages. References are made to the length of yarn on modern American back-beams and to the value of standardization of equipment and production.

31. COTTON YARN: TESTING AND TOLERANCES. (American Soc. for Testing Materials.) See Abstract 117.

32. ARIZONA: COTTON CULTIVATION, 1945-46. (*57th Ann. Rep. of Exp. Sta.*, 1945-46. From *Pl. Bre. Abs.*, xviii, **2**, 1948, p. 223.) In long-staple cotton breeding, the progenies of multiple crosses involving Pima, S × P, Tanguis, Sea Island and Upland are under selection, with a view to developing a type with a reduced size of plant and a larger boll possessing the lint length and quality of the Egyptian cotton. Upland cotton breeding work is directed towards the development of cottons superior to Santan. Progenies of the following crosses and back-crosses are under investigation: Santan × 1517, Santan × Stoneville, Santan × Wilds No. 13, Santan × (Santan × 1517), Santan × (Santan × Wilds No. 13), and Wilds No. 13 × (Santan × Wilds No. 13).

33. GEORGIA: COTTON CULTIVATION IN THE COASTAL PLAIN SECTION. (*26th Ann. Rpt. Coastal Pl. Section*, 1946. From *Pl. Bre. Abs.*, xviii, **2**, 1948, p. 217.) Upland cotton breeding is discussed. The new wilt resistant variety Pandora is being increased for distribution. It has been developed from an F_3 selection of a cross between Station 21 and Station C, and is superior in yielding ability, earliness and fibre strength. In breeding work to improve the picking quality and lint percentage of Sea Island cotton, promising Egyptian × Sea Island hybrids have been obtained.

34. COTTON VARIETIES IN THE YAZOO-MISSISSIPPI DELTA, 1944-46. By J. B. Dick and S. G. Brain. (*Bull. Miss. Agr. Exp. Sta.*, **445**, 1947, p. 13. From *Pl. Bre. Abs.*, xviii, **2**, 1948, p. 329.) The varieties tested included Stoneville 2B, Deltapine 14 and 15, Bobdel, Miller, Delfos strains, Bobshaw, Wilds, and Coker 100.

35. NORTH CAROLINA: COTTON EXPERIMENTS. (*Res. and Frmg.*, 69th Ann. Rpt. Agr. Exp. Sta. N.C., State Coll. Agr. and Eng., 1946, p. 26.) First generation hybrids between eight lines of the Coker 100 and 200 types produced definitely higher yields of seed cotton and more bolls than the average of their respective parents in 11 of the 28 hybrids studied, and four of these produced higher yields and more bolls than their best parent. Increases in yields ranged from 22 to 35 per cent. above the average of their parents. The eight parents were not radically different, but showed some variation in plant size and type, number and size of bolls, and other characteristics.

Back-crosses of crosses between Upland cotton and *Gossypium thurberi* to Upland cotton have shown fibre strengths up to 75 per cent. higher than the strength of Upland cotton, but it has not been found possible to combine this increased fibre strength with high yielding capacity.

COTTON IN EGYPT

36. Egypt: Cotton Prospects. (*Cotton*, M/c., 23/10/48.) In Lower Egypt boll opening was helped during the whole of September by a very favourable temperature; however, a few damp days were reported in Galioubieh province. Bollworm has made its appearance in the majority of provinces and has caused damage varying between 10 and 20 per cent., whereas the pink bollworm has been reported in a few districts of the Garbieh province. The north of Charkieh has suffered with the *Nadwa Assalieh*, and damage is reported. Picking, which started at the beginning of September, 10 to 15 days late when compared with last year, has become general throughout the whole of Lower Egypt. The yield per feddan in respect of the first picking varies between 3 and 6 cantars. The ginning outturn is on the whole from 1 to 3 per cent. better than that of last year.

In Upper Egypt and Fayum the temperature during the month of September was rather uneven according to provinces, but in general it helped maturing and opening of bolls. Bollworm has been reported only at Beni Suef, and the presence of pinkworm has been noted only in a few crops of the Maghagha district; damage is estimated at 15 per cent. Picking started with a delay of 15 to 20 days as compared with last year. The yield per feddan in respect of the first picking is between 5 and 6 cantars, and the crop is expected to be from 15 to 25 per cent. larger than that of last season. The ginning outturn is estimated at 2 to 3 per cent. less than that of last year.

37. Cotton Prospects, 1948. (*Cotton*, M/c., 2/10/48, p. 8.) Arrivals of the new crop from both Upper and Lower Egypt are increasing daily in Alexandria and up to date are fulfilling all expectations with regard to their quality, which in practically every case is better than last year. Picking and ginning are now in full swing in Upper Egypt, and are gradually becoming general in Lower Egypt, and weather conditions remain favourable everywhere.

38. Cotton Industry. (*Cott. and Genl. Econ. Rev.*, 5/11/48.) It is officially announced that the Government has no intention of either abolishing or reducing the cotton export tax of approximately 5.00 tallaris per cantar (or 2½d. per lb.). The Minister of Agriculture has issued a decree limiting the acreage which can be planted to cotton next year. Not more than 30 per cent. of the cultivated area in specified districts of the Northern Delta may be sown to cotton, and not more than 25 per cent. in most of the rest of Egypt. Planting will be entirely prohibited in certain parts of Upper Egypt.

39. The Cottons of Egypt. By the late H. A. Hancock. (Cotton Research Board, Orman, Giza. Government Press, Cairo, 1948.) This up-to-date account of the cotton crop of Egypt is compiled for the information of spinners, merchants, and others concerned with the technical aspects of Egypt's major production. A brief account is given of changes in the distribution of varieties during the war, and statistics are presented to show recent acreages by varieties, yields per acre, volume of production, and exports by countries. The spinning qualities and general characteristics of the cottons now and recently grown are described in some detail, and an estimate is given of the maximum counts spinnable for the different grades. Attention is drawn to the steadily rising grade of the crop in recent years, and the distribution of quantities according to grade is tabulated. Opportunity is taken to show how scientific principles (the application of organized common sense) are linked with an almost ideal cotton-growing climate and a century's experience in cotton-growing, in the effort to reduce costs of production and maintain the highest possible cotton value. The chief control methods adopted by the Egyptian Government for improving the crop are briefly reviewed, with a discussion on the subject of new varieties. Sources of statistics dealing with the Egyptian crop are listed for reference in an appendix, together with the text of the Egyptian Moisture Agreement of 1938.

40. Cotton and Cotton Statistics in Egypt. (Govt. Press, Cairo, 1948.) Part I

consists of various papers dealing with the production of cotton in Egypt; among these are the following: "The History of Cotton in Egypt" (Dr. M. M. Abdel-Salam); "Development of Superior Varieties and Provision of Bulk Supplies of Pure Seed" (C. H. Brown and H. A. El-Barbari); "Comparison of Quality of Egyptian and Other World Cottons" (C. H. Brown and A. A. Yousef); "Protection of Egyptian Cottons from Insect Pests" (M. S. El-Zoheiry Bey and I. Bishara). Part II deals with statistics covering acreage, yield, ginning outturn, etc., and the effect on the varieties sown of legislation limiting the acreage devoted to cotton-growing.

COTTON IN OTHER FOREIGN COUNTRIES

41. ARGENTINE COTTON CROP: FINANCIAL PROTECTION. By O. H. Bordarampe. (*Algodón*, 137-138, 1946, p. 358. From *J. Text. Inst.*, xxxix, 7, 1938, p. A328.) (In Spanish.) A description is given of a scheme adopted by the Argentine Government whereby a premium is collected from cotton spinners in the country per kg. of cotton consumed. The funds thus raised are used to stabilize cotton prices, to erect a system of warehouses conveniently located, to maintain a stock of reserves of benefit to the progressive industrial consumption, and to combat those natural forces which endanger the harvest.

42. ARGENTINE COTTON MILL AIR CONDITIONING PLANT. By G. T. Lang. (*Textile World*, 98, 4, 1948, pp. 118, 218. From *J. Text. Inst.*, xxxix, 7, 1948, p. A351.) An illustrated description is given of the air-conditioning system of the La Hidrofila Argentina spinning and weaving mill, Buenos Aires. The carding, spinning and weaving sections of the system are separately controlled from a central station; the last two are based on evaporative cooling. The slow air-speed system for the cardroom has special independent exhaust and intake arrangements with large, easily cleaned filters.

43. BELGIAN CONGO COTTON: SAMPLING AND BALE CLASSIFICATION. (*Bull. Com. Coton Congolais*, 8, 21, 1948, p. 13. From *J. Text. Inst.*, xxxix, 5, 1948, p. A234.) (In French.) The text is reproduced of a circular addressed to all agents in charge of a ginnery and their assistants in the Belgian Congo in order to reduce to a minimum errors in sampling and classification. Standard samples boxes for standard samples, handling of standard samples, daily samples, cases for daily samples, and the classification of bales are described.

44. CHARACTERISTICS OF CERTAIN COTTON VARIETIES, ESPECIALLY CONGO VARIETIES. By D. de Meulemeester and G. Raes. See Abstract 103.

45. BRAZIL: COTTON PROSPECTS. (*Cott. and Genl. Econ. Rev.*, 29/10/48.) Up to September 30 the quantity of cottonseed already sold had exceeded last year's figure by an average of 25 per cent. (for the same period); in certain zones the increase has reached as high as 80 per cent., which is obviously the result of the good yield produced by the new variety "Campinas." It is generally expected that for the 1949-50 season practically the whole cotton belt will be planted to this new variety. There is a noticeable revival of interest in cotton planting, and this is not only due to the fact that positive conclusions have been arrived at regarding the various causes which contributed to the failure of the last three cotton crops, but also to the fact that, in spite of the high prices that coffee is fetching, "broca"—an increasingly harmful pest—is seriously affecting coffee culture.

46. CHINA: TREE-COTTON IN YUNNAN. (Bulletins 1, 2 and 3 of the Yu-Yun Cotton Station.) Bull. No. 1.—A Note on the Growth Habit of Tree-cotton in Yunnan. By K. S. Cheng and Y. Jan. Analyses the seasonal development of 2- and 3-year-old plants in response to the climate. Although fruit-setting suggests two growth periods, the plant has really only one growing season, commencing in June and slowing down in late September. This coincides almost completely with the monsoon season.

Bull. No. 2.—Studies on the Technique in Field Experiments with Tree-cotton.

By K. S. Cheng and Y. Jan. Individual plants showed great variability. The methods commonly used in field trials, plot size, replication, etc., are considered in relation to tree-cotton as a perennial crop.

Bull. No. 3.—A Preliminary Study of the Variation in Staple Length of the Tree-cotton in Yunnan. By K. S. Cheng. There are several varieties of the perennial tree-cotton. Among them the Kaiyuan Free Seeded (in contrast to the Kaiyuan United Seeds, a kidney cotton), which is the most prolific, with a staple length of $1\frac{3}{16}$ to $1\frac{1}{4}$ inches, is the variety now recommended to the farmers. Another variety from Wenshan is of the best quality and has a very white fibre about $1\frac{1}{2}$ inches in length, but the yield and lint percentage are rather low.

The spinning qualities of the tree-cotton fibre have not been carefully studied, owing to the handicaps of the war, but it is believed that there is a great defect in lack of uniformity. The present article is the report of a preliminary study regarding the variation in lint length.

It must be mentioned that the tree-cotton yields two crops each year, the summer crop harvested in June and July and the winter crop harvested in December and January, though the picking may extend over almost three months in each season. Kaiyuan Free Seeded was the variety used in this investigation.

The range of variation was almost the same irrespective of the source of the samples, provided that they were taken at random. Seed from a single plant showed no less variability than that from different plants. The range was from 20 to 38 millimetres. As the variety Kaiyuan Free Seeded is said to be the progeny of a single plant, it would be natural to think that the influence of the environmental conditions would be very important. The flowering period covers three months in each season; the bolls must have been developed under quite different conditions, and this results in irregularities of the fibre. An investigation into the most influential factors and the time when the bolls are most sensitive would be both interesting and of practical importance.

47. China. (*Cott. and Genl. Econ. Rev.*, 15/10/48.) A joint cotton purchasing agency was formed on September 16 under the auspices of the Central Bank with a view to purchasing 2 million piculs (equivalent to 461,000 bales of 478 lb. net) of domestic cotton for mills. The agency is composed of three groups—the Central Bank, State-operated cotton mills, and private mills—and will be capitalized at 100 million gold yuan, or 25 million U.S. dollars. Cotton mills will account for 50 per cent. of the capital, which will be assessed to individual mills in accordance with the number of spindles in operation, while the Central Bank will underwrite the other half. The Central Bank undertakes further to furnish any additional capital required in future on the condition that any cotton loan should be returned to the Bank in the form of finished products—*i.e.*, cotton yarn or cloth. The agency will maintain its headquarters in Shanghai and a branch office in Hankow. Membership in the organization is compulsory for mills operating in these two cities, which will not be permitted to make cotton purchases individually. Cotton mills located in other parts of China must closely adhere to prices promulgated by the agency and will not be permitted to influence the market.

It is found that 60 per cent. of the nation's cotton fields are under control of the Chinese Communists, and that it would be necessary for China to import half of her estimated need of 1,500,000 bales for the cotton year. Under the tentative U.S. $70,000,000 aid programme E.C.A. will furnish China with nearly half of her import needs during this year, or a quarter of the total needs.

48. Cotton Industry. (*Cott. and Genl. Econ. Rev.*, 29/10/48.) It is estimated that China during the fiscal year ending June 30, 1949, is facing a shortage of raw cotton totalling 1 million bales, after taking into consideration the provision of the U.S.A. aid cotton, as well as the domestic cotton obtainable. In order to make up the difference, the United Textile Export Commission has resolved to barter textiles for raw cotton from Pakistan—a country which is regarded as capable of sparing an annual supply of some 600,000 bales of cotton for export.

49. Chinese Textile Industry: Post-War Survey. (*Text. Merc. and Argus*, **118**, 1948, p. 345. From *Summ. Curr. Lit.*, xxviii, **9/10**, 1948, p. 254.) A summarized version of the report of the United Kingdom Trade Mission to China. Pre-war developments are outlined and followed by an account of post-war reconstruction. An important feature has been the setting up of the China Textile Development Corporation to manage former Japanese-owned mills for three years; they are then to come under private ownership. Cotton output has greatly increased, making China into an exporting country. There is great demand for all types of textile machinery.

50. Chinese Textile Industry: Prospects. By F. S. Winterbottom. (*Text. Rec.*, **65**, April, 1948, p. 36. From *Summ. Curr. Lit.*, xxviii, **11**, 1948, p. 285.) The author surveys the present condition of the Chinese textile, textile machinery, and dyestuffs industry against the background of the general economic conditions. The possibilities of expanding trade between Britain and China are indicated. There are a number of tabulated production and trade statistics.

51. Netherlands Cotton Industry: Recovery. By W. T. Kroese. (*Textielwezen*, **3**, 12, 1947, p. 32; **4**, 1, 1948, p. 24; 2, 1948, p. 13. From *J. Text. Inst.*, xxxix, **5**, 1948, p. A285.) A report of a lecture on the present position of the cotton industry in the Twente and Brabant districts of the Netherlands, with statistics of exports, and particular reference to " bottle-necks " of finance and labour.

52. Peruvian Textile Industry: Development and Trends. (*Board of Trade J.*, **157**, 1948, p. 918. From *Summ. Curr. Lit.*, xxviii, **9/10**, 1948, p. 254.) The development of modern industrial enterprise in Peru, dating from shortly after the end of the first world war, is briefly traced. The production of consumer goods prevails. A table sets out figures for employment and volume and value of production in various branches of the Peruvian textile industry. The future expansion of Peruvian industry depends greatly on the co-operation of workers and the participation of foreign capital.

SOILS, SOIL EROSION AND FERTILIZERS

53. Cotton Cultivation and the Conservation of the Soil. By M. Lecomte. (*Comp. Rend. de la Sem. Agric. de Yangambi.* I.N.É.A.C., 1947.) Cotton culture has the unfortunate reputation of rapidly degrading the soil. It remains uncertain, under any given conditions, in what proportion this effect is physical or chemical. The Bambesa Station offers a typical example, although a correct rotation, according to European standards, has been applied since 1922. This system—alternation of cotton with a short leguminous fallow—has totally failed. The measures appropriate to the protection of the soil are discussed in relation to the environment of forest or savannah. Experience has shown that control must be exercised over native agriculture.

54. The Soil and its Protection in Relation to the Control of Cotton Wilt. By J. Moureau. (*Comp. Rend. de la Sem. Agric. de Yangambi.* I.N.É.A.C., 1947.) Discusses the available evidence regarding the effect of variable factors in the soil on the relationship between the cotton plant and the fungus *Fusarium vasinfectum*. Generally speaking, the conditions favouring the parasite are exactly those which are required for normal development of the host. Influences do exist, however, which make for the advantage of the cotton plant, but their usefulness is narrowly limited by local conditions. An experiment has been laid down to compare the effects on the prevalence of wilt of fallowing under tree cover and grass cover (*Pennisetum*) respectively.

STATISTICAL TREATMENT, CULTIVATION, GINNING, ETC.

55. Mechanization of African Agriculture. (*Nature*, 4/9/48, p. 366.) Problems likely to be encountered in the mechanization of African agriculture are to be studied by a mission which is visiting Uganda, Tanganyika, Nyasaland, and Nigeria. The

eader is Dr. J. R. Raeburn, of the Agricultural Economics Research Institute, Oxford, and he is accompanied by Mr. J. W. Y. Higgs, lecturer in agricultural economics, University of Reading, and Mr. R. K. Kerkham, Uganda Agricultural Service, who is at present stationed at the Uganda Agricultural Research Station. The terms of reference are: "To make a systematic survey of the sociological, economic, agricultural and technical problems which must be studied if mechanization of agriculture in the Colonies is to develop along sound lines, including *inter alia* the forms of organization required to achieve the best results (for example, whether mechanization should be on a co-operative, group, or peasant basis), the most profitable lines of future research into problems arising out of mechanization, the economics of it, and the types of tractors and implements which would be likely to be most suitable to the differing African communities, and such questions as the technical training of African craftsmen, the division and displacement of labour which will result from mechanization and its impact on current farming and social systems."

56. Statistical Methods in Research and Production. By O. L. Davies. (Oliver and Boyd, London, 1947. Price 28s. Reviewed *Pl. Bre. Abs.*, xviii, 2, 1948, p. 393.) In this book a group of chemists, engineers, and statisticians, employed by Imperial Chemical Industries Ltd. on problems of industrial research, have co-operated to produce a handbook of statistical methods in order to make available to a wider field of workers the special knowledge and information accumulated as a result of the Company's manufacturing and industrial experience. An introductory chapter deals with the scope of statistical methods. It is followed by chapters on: frequency distributions; averages and measures of dispersion; tests of significance; the analysis of variance; regression and correlation; frequency data and contingency tables; sampling; control charts; and, finally, prediction and specification. There are numerous worked examples, a useful glossary of statistical terms, and several tables.

57. Observations on Natural and Artificial Fallows in the Cotton Regions of Gandajika (Belgian Congo). By J. Maes. (*Comp. Rend. de la Sem. Agric. de Yangambi.* I.N.É.A.C., 1947.) Describes the succession and botanical composition of the colonizers of abandoned cultivations. This spontaneous vegetation is capable of maintaining, and even augmenting, the fertility of the soil. Bush fires, if allowed, favour the development of *Imperata* which is highly undesirable. The choice of plants for artificial fallows needs to be carefully made: several of the well-known cover plants are objectionable for various reasons, mainly because they favour the pests of cotton. If cassava, which has much in its favour, is used, an inedible and highly vegetative variety is desirable, otherwise its function as a cover crop is interrupted by harvesting for food. Elephant grass produces a desirable amount of humus, but makes resumption of cultivation difficult. For an artificial fallow a mixture of species is best, but the natural fallow is capable of giving equally good results. When clearing, the use of fire, by providing readily available nutrients, gives the best immediate results. Natural decay is preferable, but to be effective the cover must be cut sufficiently long beforehand to allow it to develop.

58. India: Variation in Ginning Outturn brought about by Changes in Agronomic Treatment. By Mohammad Afzal *et al.* (*3rd Confce. on Cotton Growing Problems in India,* 1946, Ind. Cent. Cott. Com. Price Rs. 4. Received 1948.) The variation produced in ginning outturn of a few Punjab American and desi cottons by some of the important agronomic treatments have been studied. Among the 4 irrigational treatments, namely different quantities of water, different intensities and frequencies of irrigation with the total quantity of water remaining constant, application of water on different dates, and flat versus ridge irrigation, only the first-named treatment produced significant variation in the ginning outturn of the Punjab American L.S.S. The ginning outturn generally declined as the quantity of water applied to the crop increased. This reduction is mainly the result of increase in seed weight.

The effect of application of increasing doses of sodium nitrate was progressively to depress the ginning outturn of the Punjab American L.S.S. This reduction was also brought about by increase in seed weight.

Sowing dates and spacings markedly affected the ginning outturn of both desi and American varieties, higher values of this character having been obtained with early sowings and closer spacings.

The lint weight per acre, however, generally improved with more liberal water supply, application of the organic fertilizer, sodium nitrate, and late sowings; wider spacing between rows also gave higher value of lint per acre in the desi variety, 39 Mollisoni, but in the American varieties closest spacing of one foot yielded highest values of both ginning percentage and lint weight per acre.

MACHINERY

59. Cotton Cleaning Apparatus. By E. H. Brooks. (U.S.P. 2,440,139, 1948. From *Text. Tech. Digest*, **5**, 8, 1948, p. 396.) Cotton is fed to a circular gin-type saw wheel with beater bars spaced around its circumference for removing trash, motes, and other foreign matter. A larger diameter brush cylinder is utilized for removing the cleaned cotton from the saw blades.

60. Lint Cleaning Apparatus. By A. S. McGinnis and H. Berry. (U.S.P. 2,439,179, 1948. From *Text. Tech. Digest.*, **5**, 8, 1948, p. 409.) This invention consists of a special baffle separator in the suction line of a conventional cyclone separator used in cleaning cottonseed lint. By the addition of a small, simple, and inexpensive baffle, a clean, high-quality product can be produced on existing apparatus.

61. Textile Finishing Machinery: Recent Development. By E. S. Pierce. (*American Dyes. Rept.*, **37**, 1948, p. 186. From *Summ. Curr. Lit.*, xxviii, **9/10**, 1948, p. 228.) A discussion of changes in the manufacture of textile machinery in general is followed by an account of recent progress in textile finishing processes and machinery. Illustrations are given of a tight-rope washer plant with J-boxes, an open-width bleaching range, a modern J-box, a 3-roller horizontal padder, a pneumatic cut-off winder, and a modern wetting and printing unit.

62. Moisture Check on Cotton Yarn. (*Ambassador*, **9**, 1948, p. 125.) The Shirley Institute has produced a new machine called an Electrical Hygrometer. It is claimed that this machine will achieve less wastage of cotton yarn and a considerable saving of fuel, combined with an increase in the production rate. The machine measures the moisture condition of the warp yarn after it has been sized, and records the degree of humidity on a meter. It is therefore possible to control the moisture content of the yarn, with the result that less yarn is wasted in storage because of under-drying, fuel is saved because the yarn is not over-dried, and production is increased from 10-15 per cent. because, with the avoidance of over-driving, the machine is run faster.

63. Machine for Picking Cotton. By J. H. Hamner *et al.* (U.S.P. 2,438,393, 1948. From *Text. Tech. Digest.*, **5**, 8, 1948, p. 397.) A machine for picking cotton from a row of cotton stalks by means of opposed power-driven belts is described. Two upwardly travelling endless belts have spindles and saw-toothed members on their surfaces to carry seed cotton to a storage unit. It is claimed that the machine removes all the cotton from the plants and leaves the bare stalks.

64. Cotton-Conveyor Blower. By C. R. Hagen. (U.S.P. 2,440,770, 1948. From *Text. Tech. Digest*, **5**, 8, 1948, p. 397.) A cotton-conveyor blower for conveying cotton from a mechanical field picking unit into a receptacle for transportation is constructed so that the seed cotton will be treated with sufficient gentleness to avoid damaging the seed.

65. Cotton-Picker Spindle Structure. By D. B. Baker. (U.S.P. 2,440,767, 1948. From *Text. Tech. Digest*, **5**, 9, 1948, p. 469.) The spindle assembly of a cotton-picking machine mounts a hollow, replaceable barb-bearing cap to minimize the inertia of the assemblies and the necessary starting torque.

66. Spindle Slats for Cotton Harvesters. By J. D. Rust. (U.S.P. 2,440,450, 1948. From *Text. Tech. Digest*, 5, 8, 1948, p. 397.) Claims are made for a new design of spindle-carrying slat which may be snapped on to the drive chain of the Rust cotton picking machine. The spindle-carrying slat provides a means of determining the angular positioning of spindles both during picking and during the stripping process.

67. Cotton-Cleaning Attachment for Harvesters. By J. C. Conrad. (U.S.P. 2,439,718, 1948. From *Text. Tech. Digest*, 5, 8, 1948, p. 409.) This invention describes a cotton-cleaning machine constructed to be attached to a tractor and used in conjunction with harvesting equipment. The machine consists of a series of beater cylinders and impaling drums which separate cotton from trash and produce a recognizably higher-grade product.

PESTS, DISEASES, AND INJURIES, AND THEIR CONTROL

68. Some Biological Aspects of Colonial Development. By Sir Frank Stockdale. In a paper read before Section D (Zoology) of the British Association on September 10, Sir Frank Stockdale discussed among many other matters the subject of the pests and diseases of plants and animals, and in particular the pests of cotton. He stressed the need for increased supplies of cotton from within the sterling area, especially at the present time. Owing to the research work of the Empire Cotton Growing Corporation and other specialists, many new types of cotton suitable for different areas and resistant to some of the pests and diseases common in those areas have been evolved and their cultivation expanded. Crop losses from jassids and other pests and certain virus diseases have been checked by breeding new resistant types. Stainers are troublesome, but not limiting; but the Red Bollworm (*Diparopsis castanea*) is the most limiting, and definitely restricts the expansion of cotton growing in large areas of Central and East and West Africa, where the climatic régime consists of a single rainy season followed by a long severe dry period. Effective agronomic methods have been devised, but the use of insecticides may be necessary before cultivation can be expanded without undue risks in large sections of the continent. The Empire Cotton Growing Corporation have had in hand a survey of the pest position in the principal cotton-growing areas of the Colonial territories in Africa since 1945, and have recently strengthened their entomological staff.

69. List of Recorded Cotton Insects of the World. By H. Hargreaves. (Pubd. by the Commonwealth Institute of Entomology, 41, Queen's Gate, London, S.W.7, 1948. Price 5s. post free.) The list was intended originally to serve as a basis for a section of a book on pests and diseases to be published by the Empire Cotton Growing Corporation, London. The aim has been to bring together for quick and easy reference the names of all insects and mites recorded from cotton in literature abstracted in the *Review of Applied Entomology*, vols. 1 to 34 inclusive. In many instances the original papers have been consulted for fuller information, and by permission of the Empire Cotton Growing Corporation new records have been included from their (as yet) unpublished lists from various countries of the British Commonwealth. The systematic arrangement of the orders and families is that adopted in the *Zoological Record*, Pt. *Insecta*, for the year 1939. The few families not represented in that volume are placed nearest to their closest allies. The small orders, Isoptéra, Thysanoptera, and Collembola, as well as the Acari, are not grouped under families. The genera in each family and the species in each genus are listed in alphabetical order. Except in a few cases in which changes were deemed advisable, the nomenclature followed is that adopted in the *Review of Applied Entomology*, from which the great majority of the records have been taken. It has always been the policy of the *Review*, the author understands, to adopt a conservative attitude to alterations in the generic assignment of species. In the course of its 34 volumes the names of certain species have been changed from time to time

in accordance with the weight of specialist opinion. The name under which a species is listed is normally that under which the most recent record in the *Review* occurs. Where the same species was recorded in earlier volumes under a different genus or genera, these are indicated in brackets and cross-referenced. Consequently, names in brackets do not necessarily indicate synonymy. If a species was recorded in one of the early volumes and has not been recorded since, it is listed under the last name under which it appeared in the *Review,* despite the fact that specialists to-day may place it in another genus. The names of species taken from originals that have not been noticed in the *Review* have not been changed, except where the records refer to species that have been recorded in it, in which case the latest names used in it have been adopted. While obvious errors of nomenclature and spelling have been corrected, no responsibility can be accepted for such mistakes in the literature or for mis-identification. A few instances of apparent error of observation or identification are drawn attention to in footnotes. The centre column of the list indicates, against each species recorded, the part or parts of the plant attacked, not necessarily all being recorded from any one country. It should be pointed out that the term "Seedling" appears to have been applied rather loosely, but it may generally be assumed to refer to cotton plants up to the stage when the stem commences to become woody, while the term "Bud" in literature originating outside the Western Hemisphere may in some instances denote "Square" (flower-bud) rather than leaf-bud, or it may include both types. The countries from which each species has been recorded are listed in alphabetical order in the right-hand column. This is not the full geographical distribution of the species, but solely that on cotton. The records from Russian territory are grouped under Transcaucasia, Turkestan, and U.S.S.R., owing to the difficulty of defining them more precisely; those under U.S.S.R. consist of the other somewhat scattered areas of the Russian Union, chiefly in south-eastern Europe. Records from the British West Indies are also not always explicit as to the island involved. Where possible the record is given under the island, otherwise it is included under the general heading of British West Indies. There are two indexes: one is to families and genera, the other geographical. In the latter the page references are sometimes followed by a number in brackets, indicating the number of times the country in question is recorded on that particular page. A complete list of the recorded pests in any one country can be easily compiled by following the page references. A very brief list of publications dealing with cotton insects is given under certain countries. Only major representative works are quoted, and the list in no way indicates the relative volume of literature from the countries concerned.

Appreciation is expressed by the author of the facilities and valuable assistance rendered by the staff of the Commonwealth Institute of Entomology, who in addition have been responsible for the preparation of the indexes, and also by the staff of the Empire Cotton Growing Corporation, at whose instigation the information in this pamphlet has been prepared for publication.

70. South Africa: Laboratory Apparatus and Technique for the Evaluation of the Toxicity and Adhesiveness of Insecticides. By B. K. Petty. (Dept. of Agric. Sci. Bull. 267, 1946. Price 3d. Received 1948.) The apparatus required for the application of stomach and contact insecticidal dusts, and for testing contact sprays and the adhesiveness of insecticidal dusts, is fully described. The methods used in carrying out the experiments, and the formula which can be used for calculating pounds of insecticide per acre from laboratory applications, is given.

71. Control of Certain Cotton Insects with DDT and Sabadilla. By G. L. Smith. (*Circ. No.* 365, *Calif. Agr. Exp. Sta.* From *Bull. Imp. Inst.*, xlv, **4**, 1947, p. 373.) Greater yields of seed cotton were obtained from plots treated with sabadilla-sulphur dusts than from untreated plots.

72. Sur la Chloruration des Noyaux Benzenique et Naphthalenique en Vue de l'Obtention d'Insecticides. By C. Kusters. (*Rep. 1st Int. Congr. Pl. Prot. Heverlee,* 1946, p. 117. From *Rev. App. Ent.*, **36**, Ser. A, 9, 1948, p. 275.)

The author reviews the methods by which the molecules of organic compounds react with chlorine, and describes the chlorination of benzene and naphthalene by substitution and by addition, and of phenol and the cresols by substitution, the synthesis of DDT, and the production of nitro- and chlor-derivatives of DDT. He discusses the contact action of the insecticides formed by these methods, and concludes that mono-substituted derivatives of benzene and naphthalene are more toxic than the original compounds, and that the degree of toxicity depends on the radical introduced, the CH_3, NH, NO, and OH radicals being increasingly effective. Di- or tri-substituted compounds are generally more toxic than mono-substituted ones, and those with two different radicals than those with two similar ones. Combinations of two or more benzene rings or derivatives of them are more toxic than single ones. Iodine, bromine and chlorine derivatives are decreasingly effective. It has been shown experimentally that the chlorination of benzene or naphthalene by addition or substitution results in insecticidal compounds, the insecticidal properties generally increasing with the percentage of chlorine, and the para position being most favourable for dichlor-derivatives; that the introduction of the NO_2 radical into a chlorine derivative increases its insecticidal effect; that the structural arrangement of the compound has a considerable influence on its activity; and that the insecticidal action of the different products is specific for certain groups or species of insects. It is pointed out that, upon chlorination, toxicity increases from mono-chlorbenzene to dichlorbenzene and is greatest for benzene hexachloride (hexachlorcyclohexane); that chlorination of phenol produces trichlorphenol and pentachlorphenol, both of which are very active; that the derivatives of cresol have a powerful insecticidal action, but also a caustic effect; that the substitution compounds of naphthalene are very toxic to both insects and mammals; and that the addition compounds of naphthalene, though less active, give rise to interesting nitrated derivatives, which are being studied. It is also emphasized that the chlor- and nitro-derivatives of DDT are very effective.

73. USE OF SELENIUM FOR PEST CONTROL. (*Nature*, 31/7/48, p. 176.) Investigations have shown that selenium salts, among other substances applied to the soil, are taken up by plants and will make the plants so treated poisonous to certain pests that attack them. Selenium compounds, such as sodium selenate, have lately been tried by a few growers for the control of chrysanthemum eelworm and some other pests of flower crops. This is dangerous because selenium compounds are poisons to man; moreover, they may persist for long periods in the soil and, if food crops are grown later in treated soil, the plants may take up the poison in sufficient amount to make them injurious to health if eaten. For the present, neither sodium selenate nor any selenium compound should in any circumstances be used for pest control purposes. The Ministry of Agriculture and Fisheries understands that no proprietary insecticide containing selenium is manufactured in Great Britain.

74. COTTON PESTS IN THE SUDAN, 1946-47. (*Rpt. of Res. Div. Dpt. Agr. and Forests*, 1946-47.) In the Gezira, incidence of pink bollworm was almost the lowest in the past ten seasons; for some unknown reason, in the last few years there has been no sudden increase in population in January. Termites were exceptionally serious at Tokar during an unusually dry season. In the same area *Creontiades pallidus* was suspected of causing considerable boll shedding. Considerable damage resulted from jassid attack in the northern and north-western Gezira and in the White Nile Schemes. About 10,000 feddans were sprayed with DDT by Messrs. Pest Control Ltd., and a preliminary study of yield returns indicates a most satisfactory increase after spraying. In connection with jassid control DDT had a greater residual effect than Gammexane, but neither gave any effective control of whitefly. Preliminary counts of jassids and of leaf scorch on cottons of varying leaf hairiness showed an inverse relationship with hairiness; an American variety A3432/8 and Tanguis showed up well. A cotton thrips (*Hercothrips sudanensis*) caused damage in the Gash Delta, and measures of control are needed. In the Gezira, Karkade (*Hibiscus sabdariffa*) acted as a trap crop to cotton flea-beetle, but the beetles have to be killed.

75. Cotton Aphids: Control by Nicotine Dusts. By C. E. Smith and I. J. Becnel. (*J. Econ. Entomol.*, 40, 1947, p. 536. From *J. Text. Inst.*, xxxix, 6, 1948, p. A288.) Several rather stable concentrated nicotine dust preparations were compared in a field study with the recommended calcium arsenate-liquid nicotine sulphate dust for controlling boll weevils and cotton aphids on cotton. None of the nicotine preparations when mixed with calcium arsenate interfered with control of boll weevil. At 2 per cent. nicotine concentration, a commercial "Dry Concentrate" equalled liquid nicotine sulphate in aphis control; both proved better than Black Leaf 155; at lower concentrations, the dry concentrate tended to perform better than the liquid sulphate. Dusts containing 1 per cent. or more nicotine produced significantly higher cotton yields and the treated plants showed fewer aphids than calcium arsenate-treated plants.

76. Cotton Jassid in the Gezira. By J. W. Cowland. (*Rpt. of Res. Div., Dept. of Agr. and For. Sudan Govt.*, 1948.) The cotton jassid is a serious pest in the northern Sudan. It is a small pale green jumping insect that feeds by penetrating and sucking phloem and xylem vessels with its proboscis (needle-like mouth parts), thus interfering with the translocation of plant food materials, and causing symptoms known as "hopper burn." The first symptom appears as a paling at the leaf edges, which extends rapidly to the tissue between the main veins. This is followed by yellowing and eventual death of the leaf tissue from the periphery inwards as if scorched by fire. In a heavy attack curling of the leaves takes place. The egg and nymphal stages are of short duration followed by a long adult life in which the female lays her eggs over a considerable period. These eggs, of which four are usually ripe at one time, are laid embedded in the soft cortex of the leaf stems and main veins, but not in the lamina. The site is quite invisible from the outside. The egg stage averages 8-10 days, and the nymphal stages 8-12 days. The length of all the immature stages increases during the winter.

From August to December cotton is the main host plant, and as this ages the insects migrate to weeds and other crops, where they exist in smaller numbers during the summer until the following year's cotton has been sown. The most important alternate hosts on which the jassids carry over during the cotton dead season are the three crops Bamia, Bedingan, and Sunflower, and the two weeds Gibbein and Hambuk. Other crops and weeds also play a part in the carry-over of jassids, including lubia, berseem, tomatoes, guava, castor oil, Egyptian bean, Tabr, Gisekia, etc. Control of the pest is at present achieved by large-scale spraying of cotton with DDT in October and November. This is successful but expensive, and two other cheaper possibilities are being explored. The first is the production of jassid-resistant cottons, work on which is being carried out by the Cotton Breeding Section of the Division with some promise of success. The production of new cottons is, however, slow work, and some years must pass before the project can bear fruit. The second possibility is the elimination of the pest during the cotton dead season, when it is concentrated on alternate hosts (mainly found in gardens and other places receiving water) by spraying with DDT in late June and early July.

77. A Systematic Study of West African Species of Dysdercus. By A. Villiers. (*Comp. Rend. de la Sem. Agric. de Yangambi.* I.N.É.A.C.) This is a study by the Head of the Zoology Section of the *Institut Français d'Afrique Noire*, based on some thousands of specimens in the collections of the Paris Natural History Museum, and puts forward a systematic revision of the five species of *Dysdercus* met with in West Africa—namely, *nigrofasciatus, melanoderes, fasciatus, hæmorrhoidalis*, and *superstitiosus*. A key to these species is followed by a full description, with a list of host-plants, and an account of their distribution. The author regards distinctions based on coloration as having little value, and has been unable to find, in the specimens examined, any convincing evidence of hybridization.

78. Laboratory Studies on the Spraying of Locusts at Rest and in Flight. By J. S. Kennedy, M. A. Ainsworth, and B. A. Toms. (Anti-Locust Bull. 2, 1948. Anti-Locust Research Centre, British Museum (Natural History), London, S.W.7.

Price 7s.) The Bulletin reports on insecticide tests with 3,5-dinitro-*ortho*-cresol (D.M.O.C.) and DDT carried out on the adult African Migratory Locust, *Locusta migratoria migratorioides* (R. and F.). The methods used for spraying the locusts are described and the formula is given for the Median Lethal Area Dosage of D.N.O.C. Comparative tests with 2·5 per cent. solutions of D.N.O.C. and crude benzene hexachloride (containing 10-12 per cent. gamma isomer) showed that D.N.O.C. was about three times the more toxic. No locusts were killed by DDT.

The toxic effect produced on the whole insect by applying D.N.O.C. solution directly to the legs was tentatively estimated as twice that produced by applications to the head and abdomen. Applications to the wings appeared to have a negligible toxic effect unless the solution was put on in very large drops which were conducted along the veins to the wing articulations. Soft, articular areas of cuticle appeared to be especially vulnerable to D.N.O.C.-oil applications, as judged by subsequent mortality. Capillary conduction of the solution along cuticular crevices to vulnerable areas was a feature of the insecticidal process, which varied in importance with drop size. The diameter of the drops of insecticide solution delivered by the spray varied between 0·2 and 0·5 mm. A larger proportion of the total dose of 0·5 mm. diameter drops was collected on the invulnerable wings in flight than at rest. Hence the flying locust required a larger total dose than did the resting one for the same mortality. The legs collected more spray than the head and trunk in all conditions. Being also, apparently, the most susceptible part of the body, the legs were responsible for most of the killing power of the spray. 0·5 mm. diameter drops fell vertically on to or past the flying locusts, but smaller drops were caught up in the local air currents created by the beating wings. Mainly on this account the dose collected by the flying locusts, and so the toxicity of a given spray dosage, increased when the drop size was reduced.

79. Le "Gammexane" dans la Lutte contre les Sauterelles. By H. J. Bredo. (*Rep. 1st Int. Cong. Pl. Prot. Heverlee*, 1946, p. 485. From *Rev. App. Ent.*, **36**, Ser. A, 9, 1948, p. 294.) There was a severe outbreak of *Nomadacris septemfasciata*, Serv., in the Lake Rukwa region of Tanganyika in 1945-46, and the supplies of sodium arsenite for use in poison baits ran short. Experiments were therefore carried out with a preparation consisting of 20 per cent. benzene hexachloride in diatomaceous earth; the γ isomer content of the benzene hexachloride was 10-12 per cent. Baits consisting of a 1 : 3 mixture of the preparation with cassava flour killed 75 per cent. of the hoppers in the first three instars in 24 hours and 98 per cent. in 48 hours. The preparation was then applied as a fine cloud to grass at an unstated rate and gave 65, 75, and 80 per cent. mortality in 24, 28, 48, and 72 hours respectively; when it was applied at half the rate, the corresponding percentages were 50, 60, and 65. Excellent results were obtained with aqueous suspensions. The dry preparation was placed in an empty petrol tin, water was added, and a suspension was formed when a brush made of a bundle of grass or fibres was plunged into it; the liquid could be thrown from the brush for a considerable distance and over a wide area. When bands of hoppers were treated in this way, the suspension gave 95 per cent. mortality of individuals in the first three instars in 6 hours at a concentration of 5 per cent. actual benzene hexachloride, and 80, 90, and 99 per cent. of hoppers in the second-fourth instars in 6, 48, and 72 hours at 2 per cent., and 70, 80, and 92 per cent. in 6, 24, and 48 hours at 1 per cent. respectively; when applied to adults, a 2 per cent. suspension killed 90 per cent. in 48 hours immediately after the final moult, and a 3 per cent. suspension killed 60 per cent. in the same time three days after it. The method gave good results against dense bands of hoppers in short, medium, and high grass (*Cynodon*, *Echinochloa*, and *Pennisetum*), and is best adapted for use on vegetation. Three days after large bands were treated, very few living hoppers could be found in the treated areas. The 60 per cent. mortality of adults obtained was considered adequate, and it was thought that, owing to their great mobility, about one-third of them had not come in contact with the insecticides. A second treatment should

therefore be applied after three days, when it is desired to control adults in phase *transiens* or *solitaria*, while the use of aeroplanes is advisable against the rapidly moving locusts in phase *gregaria*. Advantages of benzene hexachloride for use in a locust campaign include its low toxicity to man and domestic animals (a demonstrator himself swallowed a spoonful of the material with slight temporary effects only), and, if it be applied in suspension, a saving of the food materials used in baits, and ease of transport, since it can be mixed with water at the site.

80. Recent Advances in Acridology. Anatomy and Physiology of Acrididæ. By B. P. Uvarov. (*Anti-Locust Bull. I*, Anti-Locust Res. Centre, London, S.W.7, 1948. Copies obtainable from the Royal Entomological Society of London, S.W.7. Price £1 4s.) This is the first of a series of summaries each dealing with a special aspect of the locust and grasshopper problem—*e.g.*, anatomy, physiology, development, ecology, control, etc. The subject of the present bulletin is the Anatomy and Physiology of Acrididæ, and the headings of the various sections are as follows: General Morphology; Head; Thorax; Abdomen; Integument; Muscles; Digestive, Respiratory, Circulatory, Excretory, and Endocrine Systems; Œnocytes; Nervous System and Sense Organs; Sound-Producing Organs; Reproductory System; Metabolism. A list of some 280 references to the literature on the subject and an Index to Species are included.

81. Termites: Checking by DDT. By G. N. Wolcott. (*El Crisol*, **1**, 5, 1947, p. 8. From *J. Text. Inst.*, xxxix, **5**, 1948, p. A264.) Wood of the West Indian birch that had been immersed for ten minutes in a benzene solution of 2 per cent. DDT remained uneaten by the West Indian dry wood termite for more than three years. Extensive use of 5 per cent. solution of DDT for wood impregnation is recommended.

82. Nature and Prevention of Plant Diseases. By K. Starr Chester. (The Blakiston Co., Philadelphia and Toronto, 1947. Price $5.00. Reviewed *Qrtrly. Rev. of Biol.*, **23**, 3, 1948, p. 245.) In this second edition of the book first published in 1942 the subject-matter is rearranged and brought up to date, additional diseases are included, and some 30 illustrations and numerous references have been added. The book, which is designed as a textbook for students taking only a single course in plant pathology, appears to meet these requirements to a marked degree. Although considerable attention is given to general fundamental principles, procedures, and techniques of plant pathology, the book also serves as a handbook for the recognition and control of the more important plant diseases. The discussions of specific diseases are grouped according to the causal organism or condition. The well-illustrated text is divided into 20 chapters followed by a comprehensive glossary. The normally highly technical subject-matter is covered in a simple, readable style, calculated to maintain the interest of the beginning student in plant pathology. Unfamiliar terms are defined, and structures are illustrated by simple drawings. The obvious inaccuracies and ambiguities frequent in the first edition have been corrected, but a number of inaccuracies that have appeared even in the second edition are pointed out. In the reviewer's opinion the book is the most readable text on plant pathology he has encountered.

[*Cf.* Abstract 406, Vol. XX, of this Review.]

83. Diseases of Field Crops. By J. G. Dickson. (McGraw-Hill Book Company, New York and London, 1947. Price $4.50. Reviewed *Qrtrly. Rev. Biol.*, **23**, 3, 1948, p. 247.) This book covers the diseases of most of the field crops of the United States. Section IV consists of three chapters describing the diseases of cotton, flax, and tobacco. Each chapter is followed by an extensive list of references.

84. Cotton Diseases in the Sudan, 1946-47. (*Rpt. of Res. Div. Dpt. Agr. and For.*, 1946-47. Received 1948.) In general blackarm disease was earlier and more serious in the Gezira than in the previous season. A trial of disinfectants showed liquid treatment with mercuric chloriodide solution the best, with Abavit B the best of several powders. Blackarm still remains a potential menace, particularly to Sakel cotton. Leafcurl disease in the Gezira was more serious than in 1945-46.

In Wad Saadalla Block, despite a rigorous clean-up of any ratoons, the cotton crop showed considerable disease. It would seem that there are factors on which there is insufficient information. In the Gash the disease was not serious in December, 1946, but apparently a great increase in infection occurred in the early months of 1947.

85. INVESTIGATIONS ON THE RED LEAF DISEASE IN AMERICAN COTTONS: I. RED LEAF DISEASE IN SIND-AMERICAN COTTONS IN SIND. By R. H. Dastur and Kanwar Singh. (*Ind. J. of Agric. Sci.*, xvii, **5**, 1947, p. 235.) This paper gives a report of the investigation carried out in the irrigated tract of Sind. Two types of reddening depending on the physical properties of the soil have been discovered: one type in which the change in colour occurs from green to yellow and then to red, and the second type where the change is direct from green to red. These are two extremes between which intermediate stages in the two types of reddening may be found. Complete experimental evidence has been produced to show that the yellow-red leaf was caused by a deficiency of nitrogen in the leaves of plants growing on light sandy soils. The leaves of plants which showed this type of reddening during the fruiting phase contained significantly less nitrogen than the leaves of plants which were green in colour. The plants manured with sulphate of ammonia did not show the yellow-red leaf, while the symptom was found to be present in the unmanured plants in the same field. Late sown crop showed less yellow-red leaf than the early sown plants, and the nitrogen concentration was higher in the former than in the latter. In addition to the amelioration of yellow-red leaf, manuring significantly increased the yields of seed cotton per acre.

The more frequent and widespread occurrence of the yellow-red leaf in south Sind than in middle Sind and in the Punjab, even though sandy lands are common in all the three tracts, has now been explained. In addition to the soil factor—viz., sandy nature of the soil—the climatic conditions in south Sind operated in the widespread occurrence of the yellow-red leaf in that region. On account of an early drop in the temperature in July there was an early initiation of flowering. Higher day humidity in this tract reduced abscission and favoured setting of bolls. The maturation period in August, September and October coincided with high night temperatures which hastened the boll development. A large number of determinations revealed that the maturation period of bolls varied from 33 to 39 days. The crop finished off in two months—*i.e.*, in September-October. In the Punjab there was late initiation of flowering in September on account of very high temperatures in July and August, and the fruiting period therefore coincided with falling night temperatures in October, November and December. The maturation period of bolls was found to vary from 45 days to 70 days. The crop finished off at the end of December or the beginning of January.

The rapid maturation of the crop in south Sind caused heavy depletion of nitrogen from the leaves, which consequently became senescent and turned yellow and red. Thus the red leaf trouble was accentuated and it spread to lands where normally this " disease " did not appear under middle Sind and the Punjab conditions.

86. PLANT VIRUSES. By K. M. Smith. (Methuen and Co. Ltd. London, 1948. Price 6s. From *Rev. App. Mycol.*, xxvii, **10**, 1948, p. 461.) The text of the second and revised edition of this excellent little book has been entirely rewritten. The work now comprises eight chapters, an introductory one followed by others dealing, respectively, with (2) symptomatology, local lesions, virus movements in the plant, metabolism and growth of affected plants, strains and immunity; (3) transmission; (4) insect vectors; (5) the viruses themselves, their isolation, size and shape, and chemical and physical properties; (6) serology of plant viruses and classification; (7) control; and (8) the nature of viruses. A list of 102 references is appended.

[*Cf.* Abstract 483, Vol. XIII, of this Review.]

87. INDIA: INHERITANCE OF *Fusarium*-RESISTANCE IN INDIAN COTTONS. By S. G. Kelkar *et al.* (*3rd Confce. on Cotton-Growing Problems in India*, 1946, p. 125. Ind. Cent. Cott. Comm. Received 1948.) Wilt-reaction of the resistant and susceptible parental varieties, their F_1s, F_2s and B_1s with both parents, are detailed.

Segregation for wilt-resistance shown by the F_3 and B_2 progenies of the survivals from F_2s and B_1s is given. On the basis of the experimental results, a genetic basis for *Fusarium*-resistance in Indian cottons has been built up. It consists of two dominant, complementary genes, and a third one with inhibitory reaction.

GENERAL BOTANY, BREEDING, ETC.

88. COMMONWEALTH PLANT BREEDERS' MEETING. (*Nature*, 31/7/48, p. 175.) An informal meeting of Commonwealth plant breeders was held at the School of Agriculture, Cambridge, during June 24-25. Dr. P. S. Hudson, director of the Commonwealth Bureau of Plant Breeding and Genetics, acted as Chairman. Many representatives from abroad were present. The proceedings of the meeting included a review by Dr. P. S. Hudson and Mr. R. H. Richens of the work of the Commonwealth Bureau of Plant Breeding and Genetics since the last similar meeting, short reports by the delegates of the principal lines along which plant breeding is developing in the various Commonwealth countries, and an account by Dr. Hudson of the results of the meeting, held at Washington last April, between the Food and Agriculture Organization, the Commonwealth Agricultural Bureaux, the U.S. Department of Agriculture, and other bodies, on genetic stocks. Support was given to a proposal to institute a standing inquiry service whereby plant breeders should be sent details at regular intervals of all published articles bearing on their own field of research; and suggestions were made to provide for an efficient service for the maintenance of genetic stocks of crop plants.

89. EXPERIMENTAL METHODS IN AGRICULTURAL RESEARCH. By H. H. Love. (Agr. Exp. Sta. Univ. Puerto Rico, 1943. Reviewed *Pl. Bre. Abs.*, xviii, 2, 1948, p. 394.) In the first chapter the author discusses the basic idea of measuring variability and introduces in a simple manner means, standard errors, frequency distributions, and the *t* test. In the second chapter the analysis of variance is dealt with, leading on to the analysis of correlation and covariance in the following chapter. Abstruse discussions are avoided, the emphasis being all the time on actual applications. A wealth of worked examples are provided and show, in a very practical way, just how one handles raw numerical data. The fourth chapter develops the treatment and deals with several refinements and variations, introducing various new topics such as interactions, split-plot designs, confounding, and the use of transformations. The latter are often valuable in making amenable to the standard analysis of variance, treatment data which would not be so otherwise. The final chapter, "General suggestions for the conduct of experiments," is a most valuable general discussion of several important subjects connected with the carrying out of agricultural field trials, the experimental field, the size and shape of plots, border effect, sampling for yield, and so on. On the whole this is a most useful little book and well worth study by agricultural research workers who have only an elementary knowledge of mathematics.

90. HEREDITY IN PATHOLOGY. By A. Chiarugi. (In Italian. *IV Congr. Intern. Patologia Comparata, Rome*, 17, 1939, p. 155. From *Pl. Bre. Abs.*, xviii, 2, 1948, p. 250.) In this general exposé of the interrelations between genetics and plant pathology, the many genetic and cytological phenomena which may affect the life of the plant adversely are discussed in considerable detail. These include deleterious and lethal mutants, a variety of chromosome irregularities, the many chlorophyll deficiencies now known in various plants, genes causing sterility, and others causing various morphological anomalies, all of which are described by reference to the genetical literature. Unstable genes are considered in two categories, mutable genes and labile genes, and are regarded as throwing light on the chemical nature of the gene and of its changes, and affording a very direct link between genetic and pathological phenomena. After a brief reference to the question of disease resistance, the work on the genetics of the pathogenic organisms themselves is mentioned, showing that from the point of view of pathology it is the interplay of the two that

is decisive. The different types of resistance and of immunity and the manner in which they are inherited are analysed, and instances of the production of resistant strains of agricultural plants are cited from the literature of plant breeding; these include many cases where selection alone has been successful, others where hybridization has been necessary. In this latter connexion the importance of the centres of diversity of the cultivated plant species as a possible source of resistant genes is indicated, reference being made to the South American potato species, the disease-resistant wheats, and Harland's insect-resistant cotton derived from crosses with *Gossypium tomentosum*.

91. CONTEMPORARY DISCUSSIONS ON THE "NEW" SOVIET PLANT GENETICS. By A. Boerger. (In Spanish. *Cienca e Investigacion*, 3, 1947, p. 421. From *Pl. Bre. Abs.*, xviii, 2, 1948, p. 229.) An account is given of the salient features of Lysenko's genetical system, following largely the conclusions reached by Dobzhansky, and Hudson and Richens. The author resolves the apparent conflict between the Mendelian and evolutionary attitude to living organisms, and shows how several of the earlier objections to Mendelism have been met by more recent research.

92. THE NEW THEORY OF HEREDITY IN SOVIET RUSSIA. By C. Oppenheimer. (*Hassadeh*, 27, 1947, p. 516. From *Pl. Bre. Abs.*, xviii, 2, 1948, p. 229.) A fairly extensive abstract in Hebrew is presented of the publication of Hudson and Richens issued by the Commonwealth Bureau of Plant Breeding and Genetics in 1946. The author expresses the hope that it will prove possible to translate the entire publication into Hebrew, since many of the leading agriculturists in Palestine know Russian better than English, and are therefore better acquainted with Lysenko's theories than with Mendelian genetics.

93. NOTE ON THE TECHNIQUE OF COTTON PLANT SELECTION. By L. Soyer. (*Comp. Rend. de la Sem. Agric. de Yangambi.* I.N.É.A.C., 1947.) Explains in considerable detail the methods of selection practised in the Belgian Congo, as developed by long experience under conditions where European specialized personnel is small in number and expensive, the possibility of training qualified natives limited, but unqualified labour abundant and cheap.

94. PHYLETIC AND CARYOLOGIC THEORIES RELATIVE TO THE GENUS GOSSYPIUM. SOME RESULTS OF NEW NUCLEAR STUDIES, WITH PARTICULAR REFERENCE TO THE PHYLOGENY OF NEOGOSSYPIUM. By W. Wouters. (*Comp. Rend. de la Sem. Agric. de Yangambi.* I.N.E.A.C., 1947.) A discussion of polyploidy. Chromosome variability, too much neglected in cytogenetics, is held to account for the divergences, otherwise inexplicable, between investigators.

95. INDIA: SOME CONSIDERATION OF INTERSPECIFIC HYBRIDS AND POLYPLOIDS IN COTTON. By G. B. Patel *et al.* (*3rd Confce. on Cotton-Growing Problems in India*, 1946. Ind. Cent. Cott. Comm. Received 1948.) The polyploids resulting from chromosome doubling in natural diploid and amphidiploid species, both cultivated and wild, are generally sterile. Chromosome doubling in the sterile allotriploid hybrids of cultivated New World and cultivated Asiatic cottons results in fairly fertile hexaploids which, though not economically useful by themselves, can be of great indirect value for the synthesis of an allotetraploid of the genomic constitution of New World cottons. The species relationship in *Gossypium* is such that in the building up of an artificial allotetraploid of the genomic constitution of New World cottons (which include the world's best-quality cottons), one of the species has necessarily to be a wild one, which introduces many undesirable characters in the polyploid. This can, however, be remedied by crossing with cultivated New World cottons. The fact that such a synthesis is possible opens up a wider field for research by bridging up the gulf between the various species. It also extends the scope for studying the interaction between their genoms, for judging their relationship, and for combining the desirable characters to economic ends.

The fact that some of the first back-crosses of (cultivated New World × cultivated Asiatic) × cultivated New World cottons are of the genomic constitution of the New World cottons, and are also chromosomally balanced, gives scope for further breeding

operations with a view to combining desirable characters of the two economically useful groups of species, wherein the sterility of the first generation hybrid was a great barrier.

96. INDIA: A REVIEW OF CHROMOSOME CONJUGATION IN ALLOTETRAPLOID COTTONS. By N. K. Iyengar. (*3rd Confce. on Cotton-Growing Problems in India*, 1946. Ind. Cent. Cott. Comm. Price Rs. 4. Received 1948.) Chromosome conjugation is described in the allotetraploid cottons of various origin. It is pointed out that, in general, the chromosome conjugation in the tetraploids depends upon the genomic relations of the species involved. Other factors like autosyndesis brought about by polyploidy in the present-day diploid and tetraploid species, structural changes, etc., also influence conjugation, and deviations from the expectation are often to be anticipated. The utility of the allotetraploids from the point of practical plant breeding and species formation is briefly discussed.

97. AMERICAN COTTONS: THEIR CULTIVATION AND BREEDING IN MYSORE. By L. S. Dorasami and G. S. Iyengar. See Abstract 12.

98. ABNORMAL FEMALE GAMETOPHYTES IN RELATION WITH POLYEMBRYONIC SEEDS IN UPLAND COTTON. By A. Quintanilha *et al.* (*S. Afr. J. Sci.*, **43**, 1947, p. 158. From *Pl. Bre. Abs.*, xviii, **2**, 1948, p. 328.) Descriptions are given of two cases of abnormal embryo sacs in the Upland cotton variety 9L36. In the first case of abnormality the embryo sac, which was examined before fertilization, contained two egg cells, four synergids and four polar nuclei, instead of the single egg cell, two synergids and two polar nuclei usually found. The antipodal cells, of which there must have been six, had degenerated as usual. The second embryo sac was examined after fertilization. Before fertilization it must have had the same constitution as the first embryo sac. When the two male nuclei entered the embryo sac, one must have fused with one of the egg cells, the other with one pair of polar nuclei, and the triploid endosperm mother cell must have begun to divide immediately. The ovule showed one fertilized and one unfertilized egg cell, two normal synergids, two synergids digested at the entrance of the pollen tube as normally occurs, the pair of polar nuclei not yet fused, and the first two nuclei produced by the division of the endosperm mother cell. If this ovule had continued to develop it would probably have given rise to heterogeneous twin seeds, one diploid and the other a parthenogenetically developed haploid. It is thought that an abnormal embryo sac of the type described arises as the result of an extra division of the fourth surviving megaspore.

99. A RECESSIVE NAKED-SEED CHARACTER IN UPLAND COTTON. By J. O. Ware *et al.* (*J. Hered.*, **38**, 1947, p. 313. From *Pl. Bre. Abs.*, xviii, **3**, 1948, p. 540.) Simple dominance of naked seed over fuzzy seed has previously been reported in Upland cotton. The data from crosses of Acadian Brown, a non-commercial variety of Upland cotton with naked seed from Louisiana, with fuzzy seeded varieties have shown that the character of naked seed in Acadian Brown is recessive to the fuzzy seed of the other varieties, but that dominance of the latter character is incomplete. The results obtained by crossing Acala Mex, a variety possessing naked seed as a dominant character, and Acadian Brown suggest that the apparent dominance of naked seed hitherto found in Upland cotton is due to an inhibiting gene epistatic to a gene for the development of fuzz rather than to the pure dominance of a gene for naked seed. On the other hand, the naked character in Acadian Brown appears to be determined by a single recessive gene.

100. COTTON SEED HAIRS: STRUCTURE AND DEVELOPMENT. By A. S. Heiba. (*Science*, **107**, 1948, p. 650. From *Summ. Curr. Lit.*, xxviii, **14/15**, 1948, p. 355.) The structure and development of seed hairs of different species of *Gossypium* have been studied and the results indicate that the unicellular lint hairs of cultivated cotton may be developmentally derived from multicellular wild type seed hairs through an evolutionary process that progressively reduced a primitive, strongly thickened, multicellular structure to a unicellular, partly thickened, long hair (lint) and a unicellular, strongly thickened, short hair (fuzz). The seed hairs of *Gossypium*

can therefore be differentiated as follows: (i) multicellular type—*e.g.*, seed hairs of *G. thurberi* and *G. klotzschianum*; (ii) binuclear type, one nucleus subsequently degenerating—*e.g.*, lint hairs of cultivated cottons; and (iii) uninuclear type—*e.g.*, fuzz hairs of cultivated cottons.

101. The Effect of Calcium and Other Ions on the Early Development of the Radicle of Cotton Seedlings. By J. T. Presley and O. A. Leonard. (*Pl. Physiol.*, 23, 4, 1948, p. 516.) Seeds of Upland cotton of the Half and Half variety were germinated in Petri dishes at high and low moisture levels. Cations were varied in the water used in germinating the cotton seeds as well as in the solutions in which the seedlings were subsequently placed. The radicles of seeds germinated under low moisture conditions absorbed an excess of water when they were transferred to the various solutions. The air in the intercellular spaces was displaced. After four days the radicles were mostly broken down by secondary bacterial action. Calcium salts added to tap water or distilled water resulted in a higher percentage of healthy radicles. Radicles developing at the high moisture levels did not absorb water to the extent of crowding out all of the air from the intercellular spaces. When adequate calcium was present these radicles remained healthy and grew rapidly. In distilled water the radicles became unhealthy, and some breakdown was apparent in about four days. The progress of the breakdown was appreciably hastened by salts of magnesium, sodium, or potassium. The Upland varieties of cotton tested appeared to be more sensitive to calcium deficiency than any of the other seedlings tested. The two conditions necessary for producing cotton seedlings with healthy radicles are adequate moisture during the germination period and adequate calcium during early stages of growth.

102. Rate of Leaf Elongation as Affected by the Intensity of the Total Soil Moisture Stress. By C. H. Wadleigh and H. G. Gauch. (*Pl. Physiol.*, 23, 4, 1948, p. 485.) The rate of leaf elongation on cotton plants was ascertained with respect to increasing intensity of the soil moisture stress. Leaf elongation virtually ceased at the higher intensities of induced stress and resumed on alleviation of the stress by irrigation. During a given irrigation cycle, elongation was expressed empirically as a second degree function of soil moisture stress. This functional relationship was characterized by an approach to a maximum at the theoretical time at which growth ceased. Since the derivative becomes zero at a maximum, this value is used in solving the differentiated equations for the intensity of soil moisture stress limiting to leaf elongation by using the empirically derived constants for the functional relationship between leaf length and moisture stress. This procedure gave values consistently close to 15 atmospheres for the moisture stress inducing leaf-growth cessation for (*a*) different irrigation cycles during the growth of a given leaf; (*b*) different leaves on the same plant; and (*c*) leaves on different plants.

103. Characteristics of Certain Cotton Varieties, especially Congo Varieties. By D. de Meulemeester and G. Raes. (Publ. Inst. Nat. Agron. Congo Belge, Sér. Tech. Nos. 34 and 35, 1947.) In the first paper the description is given of various tests to determine the quality of cotton fibres of different varieties of cotton, and the methods employed are discussed. The second paper deals with experiments to determine the strength of cotton fibres. The two methods used are compared and the results tabulated.

104. Cotton Fibre: Development and Properties. By E. E. Berkley. (*Text. Res. J.*, 18, 1948, p. 71. From *J. Text. Inst.*, xxxix, 7, 1948, p. A341.) A fairly comprehensive account is given of the morphology and physiology of the cotton fibre, together with details of physical and spinning properties of different varieties. There are a number of drawings, photographs, photomicrographs, tabulated and graphical data, and 35 references to the literature, most of them very recent.

105. Cotton Fibre: Elongation during Growth. By A. N. Gulati, K. R. Sen, and B. K. Kar. (*J. Sci. Club*, India, 1, 3/4, 1948, p. 41. From *Summ. Curr. Lit.*, xxviii, 16, 1948, p. 379.) (1) The theory of fibre development inside a boll,

developed by Sen and Kar, is critically considered. There does not seem to be sufficient evidence to show that fibre elongation is not affected by changes in temperature and is consequently independent of photo-synthesis. Proofs for true growth during elongation of cotton are submitted and the attenuation hypothesis is attacked. (2) A defence of the theory of fibre development and a rejection of Gulati's arguments.

106. Further Studies on the Inheritance of Anthocyanin Pigmentation in Asiatic Cotton. By Chi Pao Yu and Te Sun Chang. (*J. Genetics*, **49**, 1, 1948, p. 46.) The so-called multiple allelic series of anthocyanin pigmentation of Asiatic cotton is extended from fourteen to twenty members. Two of the additional members were found in indigenous material, and the remaining four were synthesized from existing types. The genetic substance affecting the characters in this so-called multiple allelic series seems to be separable. Sometimes, in certain crosses, two members of the series may be combined to form another one, or, on the other hand, one member may be split into two others. But such combining and splitting take place only between petal characters, or between plant-body coloration and petal characters; and plant-body coloration, itself, seems to be very stable. At least in one case the crossing-over phenomenon is very clearly established, in that both cross-overs and parental types are recovered in the F_2 progeny. The so-called multiple allelic series, therefore, may be subdivided into several series. In addition to the facts presented in this paper, evidence of closely linked genes affecting the same part of the body tissue has been reported recently both in corn and in the mouse.

Hutchinson's explanation of the inheritance of anthocyanin pigmentation in Asiatic cotton is considered in detail in this paper. It is found that some modification is necessary to make it fit the new facts. Probably a three-unit mechanism will prove more acceptable than his original two-gene-centre hypothesis. In spite of requiring minor modifications, however, his hypothesis agrees reasonably well with the cytological findings recently reported in corn. That the three units may really be three closely linked but separable loci is in accordance with the genetic facts. On this basis, there is a multiple allelic series corresponding to each locus—namely, plant-body coloration, ghost spot, and spotless series. These consist of nine, three, and three alleles respectively; and the number of possible combinations among the series is sufficient to account for the existing types.

A new system of nomenclature of anthocyanin characters in Asiatic cottons is suggested, in order to illustrate the genetic behaviour of the members and to clarify the relationship of the different types.

107. Cotton: Versatile Textile Fibre. By E. E. Berkley. (*Text. Res. J.*, **18**, 1948, p. 71. From *Text. Tech. Digest*, **5**, 8, 1948, p. 396.) A review of recent researches on cotton, including the origin, growth, structure, and natural variations of the fibre. The physical properties, spinning quality, and modifications by chemical and physical treatment of the fibre are also discussed.

FIBRES, YARNS, SPINNING, WEAVING, ETC.

108. Cellulose Fibres: Grinding; Effect on Crystallinity. By M. L. Nelson and C. M. Conrad. (*Text. Red. J.*, **18**, 1948, p. 115. From *J. Text. Inst.*, xxxix, 7, 1948, p. A342.) It has been shown that when samples of purified linters and cut cotton are ground—*e.g.*, in a Wiley mill—a reduction in the degree of crystallinity takes place which increases with the severity of grinding. When the ground samples are moistened with water and allowed to dry, part of the lost crystallinity is regained. The results obtained by acid hydrolysis measurements are confirmed by accessibility, heat of wetting and moisture adsorption measurements. Even the most severe grinding is without effect on X-ray diffraction patterns. Some implications of the results on the interpretation of cellulose structure are discussed.

109. Discovering Cotton. By L. Smith and G. S. Buck. (*Text. Col.*, **69**, 11, 1947, p. 11. From *Text. Tech. Digest*, **5**, 6, 1948, p. 259.) Qualities of cotton,

including absorbency, strength, launderability, colour fastness, and dimensional stability are discussed in relation to future research. A brief description of the structure of the cotton fibre is also given.

110. COTTON: CLASSIFICATION AND SELECTION FOR BLENDING. By S. Carter. (*Text. World*, **98**, 2, 1948, pp. 118, 194. From *J. Text. Inst.*, xxxix, **7**, 1948, p. A330.) Specimen classification and inventory sheets are shown to illustrate the value of careful classing and bale selection in cotton blending, of which an account is given.

111. COTTON FABRICS: BLEACHING; EFFECT ON STRENGTH AND OTHER PROPERTIES. By J. H. Kettering and R. M. Kraemer. (U.S. Dept. of Agric., *Tech. Bull.*, **941**, August, 1947. From *Summ. Curr. Lit.*, xxviii, **9/10**, 1948, p. 225.) Eleven varieties of three modern commercial bleaching methods were investigated for their effect on the fabric: caustic soda kier boil and hypochlorite bleach (1); caustic soda kier boil and hydrogen peroxide kier bleach (2); and continuous bleaching (3). In order of content of residual impurities (alcohol-soluble materials, wax and ash) and high cellulose content, (1) was better than (3), which was better than (2). In order of change in fabric properties (breaking loads, thicknesses, weights and fluidities), (2) was slightly better than (3), which was better than (1). The one process using chlorite showed excessive degradation as measured by fluidities in cuprammonium hydroxide. Reflectance and absorbability measurements revealed no differences between the methods. Desizing treatments degraded the fabrics slightly and increased moisture contents and the apparent amounts of alcohol-soluble materials and wax in the fabrics. Hard water and faulty washing procedures gave rise to high wax contents, soft water and efficient washing removed practically all the wax. Breaking load measurements on fabrics from any one process usually reveal the fabrics damaged in the process, but should not be used as a basis for selecting processes. Despite various disadvantages, all methods proved satisfactory and produced good quality fabrics. Results are presented in detailed tabulated form, and there are 29 references to the literature.

112. COTTON FIBRE: DESTRUCTION BY INSOLATION. By F. I. Sador and V. S. Artemova. (*Tekstil. Prom.*, **7**, 1947, p. 22. From *Summ. Curr. Lit.*, xxviii, **14/15**, 1948, p. 345.) Cotton in the raw and bleached conditions was exposed to predominantly sunny weather, and the degradation produced was followed by measurements of tensile strength, cuprammonium viscosity, and copper number. "DCU," a condensate of dicyandiamide and formaldehyde, and Blankophors R and Rg (I.G.), the fluorescent whitening agents, were examined for their protective influence. Whilst in 50 days' exposure an untreated bleached fabric lost 32 per cent. of its strength, the same fabric treated with Blankophor Rg lost only 4 per cent.; treatment with Blankophor R was without effect.

113. NITROGEN CONTENT OF COTTON IN RELATION TO OTHER FIBRE PROPERTIES. By F. M. Eaton. (*Text. Res. J.*, **17**, 1947, p. 568. From *Text. Tech. Digest*, **5**, 8, 1948, p. 396.) By using simple correlation coefficients, comparisons are made between variations in the total nitrogen content of cotton fibres and variations in the physical properties of these fibres and their yarns. Methods and materials used in making this comparison are described and the results obtained are discussed.

114. THE PREDICTION OF SPINNING VALUE OF GAORANI (BANI) COTTONS. By P. D. Gadkari and Nazir Ahmad. (*Ind. J. of Agric. Sci.*, xvii, **1**, 1947, p. 55.) During the period 1932-1941, 111 samples of Gaorani (Bani) cotton belonging to the group *G. arboreum* var. *neglectum* forma *indica* were tested for their fibre properties and spinning performance in the Technological Laboratory, Matunga. The available data have been utilized to evolve a prediction formula for these cottons. Table I shows the correlation coefficients between mean fibre length and mean fibre weight; Table II shows the correlation coefficients between highest standard warp counts and fibre length and mean fibre-weight per inch; and Table III shows the agreement between actual spinning values and those from formulæ for 111 Gaorani strains.

115. Cotton Sliver: Impregnation with Silica; Effect on Strength. By E. A. Murray, J. W. Moore, and S. Williams. (*Text. Res. J.*, **17**, 1947, pp. 331, 616. From *J. Text. Inst.*, xxxix, 5, 1948, p. A239.) An investigation has been made of the effect on yarn properties of the application of colloidal silica (Syton) to cotton card slivers by a continuous single-end treatment. The apparatus consisted of a treating bath, squeeze rollers and an infra-red drying tunnel, followed by a coiler head for winding the treated sliver again into a package. Five cotton samples of different varieties, and staple lengths ranging from $\frac{3}{16}$ to $1\frac{1}{4}$ in. were tested. The deposition of silica apparently increased the inter-fibre friction and made possible the production of yarns of increased strength at lower twists than normal. Thus one sample of Bobshaw cotton, treated to contain silica in various concentrations from 0·5 to 3·3 per cent., exhibited yarn strength increases from 4 to 55 per cent., depending on silica concentration, yarn count and twist. Maximum yarn strength was always obtained at a lower twist than that required to develop maximum strength in untreated cotton, and invariably the lea strength of the treated cotton at the lowest twist factor spinnable exceeded the maximum strength of untreated cotton of the same variety and staple length. Yarns from treated sliver were somewhat less uniform than normal yarns, and this was reflected in a lower degree of reproducibility of the lea strengths. It was found possible to treat draw-frame sliver in the same manner as card sliver: the same type of increases in yarn strength were realized. Some silica was lost during the various drafting operations in the processing of treated sliver; the greatest loss occurred during drawing. A considerable reduction in roving twist was found to facilitate the spinning of the treated cotton, and somewhat greater roller spacings than usual gave improved results. Uniformity of impregnation was found to be an important factor. On the whole, impregnation of draw-frame sliver gave rather better results than that of card sliver. Direct application of Syton to yarn resulted in somewhat smaller strength increases than were obtained by treatment prior to spinning.

116. Cotton Yarn: Fibre Draft Distribution; Effect on Strength and Appearance. By L. A. Fiori. (*Text. Ind.*, **112**, 6, 1948, p. 92. From *Summ. Curr. Lit.*, xxviii, 17, 1948, p. 393.) Four varieties of cotton (staple length 1 in., $1\frac{3}{32}$ in., $1\frac{3}{8}$ in. and $1\frac{1}{2}$ in.) have been spun into relatively coarse yarn under different conditions of draft between the drawing, intermediate and spinning frames. Examination of the skein strengths (corrected to 15·75s counts) and appearances of the finished yarns showed that (1) spinning drafts of 12 to 25 varied inversely with skein strengths but had no visible effects on yarn grade; (2) roving frame drafts of 8 to 16 and drawing frame drafts of 4 to 8, with simultaneous doubling of 4 to 8, did not appreciably affect strength or grade; and (3) yarn spun after two drawframe passages did not show any improvement in strength or grade over yarn spun after only one passage. Full experimental details are presented in tabulated form.

117. Cotton Yarn: Testing and Tolerances. American Soc. for Testing Materials. (*A.S.T.M. Standards on Textile Materials*, 1948, p. 212. From *J. Text. Inst.*, xxxix, 7, 1948, p. A344.) Details are given of A.S.T.M. Standard D180-47T, which deals with "Tentative Methods of Testing and Tolerances for Cotton Yarns," mainly for breaking load, count, twist and appearance. An appendix deals with testing under prevailing atmospheric condition.

118. Cotton Yarns and Fabrics: Quality Control. By E. Hard. (*Text. Indust.*, **112**, 2, 1948, p. 105. From *J. Text. Inst.*, xxxix, 7, 1948, p. A344.) A detailed explanation is given of a system for promptly spotting and correcting defective production; specimen record cards and "trouble shooter tickets" are included.

119. Textiles: Flame-Proofing. By R. W. Little. (*Amer. Dyes. Rept.*, **37**, 1948, p. 114. From *Summ. Curr. Lit.*, xxviii, 9/10, 1948, p. 229.) A report of a lecture. A review is made of inflammability legislation, causes of textile fires are discussed, and current methods of flame-proofing are described. A discussion is reported.

120. LABORATORY METHODS FOR TESTING THE RESISTANCE OF TEXTILES TO ATTACK BY FUNGI. By G. C. Wade. (*J. Coun. Sci. Indus. Res. Aust.*, xx, 4, 1947, p. 445. From *Rev. App. Mycol.*, xxvii, 9, 1948, p. 438.) In pure culture tests of the resistance of treated textiles to fungal attack carried out at the Victoria Dept. of Agriculture and Munitions Supply Laboratories, the method of Thom *et al.* was at first used, with *Stachybotrys atra* as the test organism, the inoculations being made with an atomizer. In later tests, *Memnoniella echinata* replaced *S. atra*, and *Aspergillus niger* was used for testing water-proofing losses. Inoculation with mixed fungi was not adopted, as many were mutually antagonistic. When untreated cotton duck was inoculated with *M. echinata, S. atra, Chætomium* sp., and combinations of these, *M. echinata* became important and other fungi were excluded. *Chætomium* and *Stachybotrys*, when used together, grew each in a well-defined area and did not invade parts already affected by the other. The tensile strength of duck inoculated with a mixture of *M. echinata* and *Chætomium*, or of these with *S. atra*, was significantly greater after inoculation than that of duck inoculated with *M. echinata* alone. *S. atra* was found to produce a toxic principle inhibiting the growth of *A. niger* and *M. echinata*, and *Penicillium luteum* one inhibiting *A. niger*.

The results of experiments to determine the optimum moisture content for soil burial tests indicated that when the moisture content was 50 to 70 per cent. of the water-holding capacity there was small variation in loss of tensile strength of cotton duck strips, but at 80 per cent. deterioration was greater. The rate of loss of tensile strength at 90 per cent. water-holding capacity was high during the first seven days, but then declined rapidly.

TRADE, PRICES, NEW USES, ETC.

121. COTTON OPERATIVES: SCIENTIFIC DEPLOYMENT. By L. H. C. Tippett. (*Times Rev. Indus.*, March, 1948, p. 6. From *Summ. Curr. Lit.*, xxviii, 9/10, 1948, p. 255.) A general review is given of the need for increasing productivity in the cotton industry and methods of achieving this; the progress so far achieved by the application of time and motion study and work load assessment methods; and the factors affecting future prospects.

122. COTTON TRADE: HISTORY. By H. Wescher. (*Ciba Review*, 64, 1948, p. 2322. From *J. Text. Inst.*, xxxix, 7, 1948, p. A368.) Historical accounts are given of the cotton industry and trade in the ancient world and the Middle Ages, under the headings: (1) Cotton in the ancient world; (2) The beginnings of the cotton industry in Europe; (3) Cotton growing and cotton trade in the Orient during the Middle Ages; and (4) Fustian weaving in south Germany from the fourteenth to the sixteenth centuries.

123. DUST IN COTTON MILLS. (*Cotton*, M/c., 2/10/48.) Describes how the Shirley Institute, in collaboration with the Departments of Industrial Hygiene and Public Health at the University of Manchester, is attempting to solve the problem of the cause and removal of byssinosis, a respiratory disease among cotton workers. Two methods of getting rid of the dust had been considered: (1) Avoidance of the introduction of the dust into this country by its removal at the gin. The Institute was working on these lines in collaboration with the U.S. Department of Agriculture, using as the basis a new kind of opening machine developed at the Institute some years ago. The second method consisted of oiling cotton during its preliminary opening treatment. This had been tried recently with promising results. Work was also continuing on the development of methods for the mass removal of dust from the atmosphere, for ordinary ventilation methods did not provide a solution to the problem.

MISCELLANEOUS

124. PROCEEDINGS OF THE SEVENTH PLENARY MEETING OF THE INTERNATIONAL COTTON ADVISORY COMMITTEE, EGYPT, APRIL, 1948. (Washington, D.C. Price

$1; also available in French.) In this report the account of the opening Plenary Session, in which the Committee was welcomed on behalf of the Egyptian Government by H.E. Nokrashy Pasha, is followed by the reports of the Retiring Chairman and of the Secretariat, and these by the statements and reports of Member Governments. There are included a review of the Current World Cotton Situation in April, 1948, statistical tables, and illustrative charts. The volume closes with the reports of sub-committees and the text of the resolutions adopted by the Meeting.

The report of the Secretariat records that 1947-48 was the first year throughout which the Committee has had the services of a whole-time staff. The Secretariat has, in consequence, been able to apply itself effectively to the duty of " supplying complete, authentic and timely statistics on world cotton production, trade, consumption, stocks and prices " as laid down by the Fifth Plenary Meeting.

ERRATUM

HABARI YA NZIGE, by R. C. Rainey. Vol. XXV, No. 4, p. 260, last line: *for* Uganda, *read* Africa.

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THE EMPIRE COTTON GROWING REVIEW

VOL. XXVI APRIL, 1949 No. 2

THE UGANDA COTTON INDUSTRY

AT ten-yearly intervals, in 1929, 1938 and 1948, the Government of Uganda has appointed Commissions to consider and advise upon conditions in the local cotton industry. The earlier bodies had terms of reference covering the whole field, the latest was restricted to matters of marketing and buying of seed-cotton, ginning and transport, and the construction of a price formula which will permit of an assessment of the value of seed-cotton prior to purchase. As a basis for its enquiry, the Commission were charged with the duty of investigating the proposals made in a report on these matters by Sir Charles Lockhart in 1947.

Whether arising from defects in the advice previously tendered to the Government, or from difficulties in its application, the present report* reveals that the position with regard to questions referred to the Commission is very far from satisfactory in several major respects, and would seem to call for resolute action. Many of the complaints regarding Uganda cotton which have been heard from Lancashire will find here a more than adequate explanation.

The difficulties of marketing arise in the first instance from the multitude of small growers widely scattered through the districts, each of whom, under the prevailing system, takes his crop of seed-cotton, in whatever container is available, to a buying centre for disposal to the ginners' agents. If the buying centres are multiplied for convenience of access, they are small and difficult to supervise, if they are reduced and centralized, they involve long distances of travel from the outer fringes. A system has developed in which growers and their loads are picked up by the buyers' lorries, taken to the market and returned to their homes. This is obviously wasteful of both time and transport, but no alternative presents itself until local co-operative societies can be organized to take over the collection and marketing of the cotton. This would appear to be an ideal solution to many of the difficulties and abuses which exist, but the Commission were told by the Registrar that the movement is slow of growth, and will take many years to reach significant proportions. The Commission recommended that all possible encouragement, guidance and assistance should be given by Government.

* Report of the Uganda Cotton Industry Commission, 1948, Govt. Printer, Entebbe. 2s.

The Commission were profoundly shocked by the volume and convincing nature of the evidence of widespread deliberate cheating of the grower over the selling of his cotton. Although fixed prices must be paid, only a very small minority of growers can read the figures on the scales, and there is evidence of buyers being expected, or even required, by their employers to bring in 10 to 15 per cent. more cotton than they have paid for. This is a type of trouble which has arisen over and over again in British dependencies where produce is collected from illiterate farmers. It is notorious among the cocoa farmers of the Gold Coast and the cane farmers of Trinidad, and is extremely difficult to meet where the opportunities are so obvious and the moral resistance low. It is not a question of race; the only difference would appear to be, in the case of Uganda, that the Indian is regarded as more expert at the game. The Uganda Government in a prefatory note seeks to minimize the effect of the Commission's revelations by claiming that cotton buying is in no worse case than other commercial operations, in which dishonesty and frauds are prevalent throughout Uganda! The Commission make a number of detailed recommendations which, so far as they are feasible, would at least make cheating more difficult. Here, again, is a position which would be greatly improved by the development of co-operative societies.

In its next section the Report deals with the organization of ginning. In order to avoid unbridled uneconomic competition between ginneries, they are at present mostly operated under pooling agreements, each covering a specified district, and providing for a quota of the available business proportionate to ginning capacity. These pools have at present no statutory basis. The incentives of free competition making for efficiency and economy are absent, and the Commission are satisfied that only the most drastic reorganization and rationalization will enable the industry to hold its own with competitors in other countries in future years. They are theoretically in favour of free competition, and would prefer it to the *status quo*, but recognize that its restoration would lead to new abuses. They do not, however, adopt the logical alternative, which would be a fully planned system such as that which has operated with such conspicuous efficiency in the Belgian Congo, where a district monopoly under appropriate safeguards is given to a responsible company. They would agree that the present system has the defects of both alternatives and the merits of neither. What the Commission do recommend is a bargain between the Government and the Uganda Cotton Association by which the pools would receive statutory authority for a five-year period on condition that within 12 months a detailed plan should be submitted for approval, providing for the reorganization and rationalization of the ginning industry. To the onlooker the incentive seems inadequate!

As to the standards of the present ginneries, there is another sorry tale to unfold. On the evidence of the Inspector of Factories, confirmed by direct observation, their average condition is reported to be "shocking." The machinery is antiquated, the buildings old and unhygienic. Seed cotton and cotton seed are often stored under "appalling" conditions: leaky roofs, damp floors, and in one case noted, infestation throughout with stainers. The evidence of Senior Agricultural Officers is to the effect that their best efforts to provide for the issue of seed of pure and improved types of cotton are frustrated by lack of co-operation at the ginneries. As an instance: after ten years and the issue of four waves of BP 52 there is still in Buganda a third of the old type remaining. In Busoga the position is much worse!

Similar defects apply to the quality of the lint turned out; the main source of the present widespread complaints of irregularity is the absence of primary classification by the ginner, which no subsequent grading can overcome.

The attention of the Commission was directed to the necessity for the provision of some form of Lint Marketing Board. Since 1943 a price to the grower has been guaranteed before the commencement of crop marketing, and any surplus derived from the subsequent sale of lint and seed has been placed to a reserve fund. The Cotton Exporters' Group was formed to act as agent of the Government in the collection of this surplus, and to be an intermediary between ginners and exporters. The proposed board is intended to take over these functions. The Commission have considered sympathetically the expressed desire of exporters and ginners to return to pre-war marketing conditions, and agree with the contention that the lowering of quality is partially due to the policy of bulk sales. They note, on the other hand, the difficulties of such a return entailed by the closing of the Liverpool Cotton Market. They feel compelled to take the view that purchase at a guaranteed price necessitates controlled marketing. In order to maintain the standards of quality, they recommend as essential that contracts for the purchase of lint from ginners should be made on identical terms in regard to quality with those covering sales by the Board to the consumers. This would enable more careful classification and better ginning to be rewarded by a premium and bad selection and ginning correspondingly penalized. They also recommend that sales should be restricted to licensed exporters and suggest the formation of an organized Exporters' Association.

There are two matters outside the terms of reference on which the Commission nevertheless express their views. One is the urgent necessity for increased storage facilities at railhead, the other the strength of the Agricultural Department's staff, which they regard as quite inadequate for its responsibilities. They quote the evidence of

the Director of Agriculture on the possibilities of increased yields. "The present average yield is about 230 lb. per acre, and the Agricultural Department knows that, doing nothing the African cannot do for himself, a yield of 500 lb. per acre could easily be produced." Such an increase could augment the annual value of the cotton crop by over 10 million pounds.

REVIEW

A HUNDRED YEARS OF INDIAN COTTON. By M. L. Dantwala. (The East Indian Cotton Association Ltd., Bombay. 1947.) Issued to mark the completion of a century of arrivals of cotton in Bombay for local sale or shipment abroad, this book, nicely produced and well illustrated as befits a souvenir volume, records, with copious quotations from, or summaries of, the original documents, the history of the Indian cotton trade. From, and long before the time, 450 B.C., when Herodotus recorded that "India had wild trees that bore fleeces as their fruit. . . . Of these the Indians made their clothes," India was the base of cotton manufacture. The Industrial Revolution in Britain reversed the wheels and changed the emphasis of her economy from the export of calicoes to the export of raw cotton, to be re-imported as cloth from the Lancashire mills. A Select Committee of the House of Commons appointed in 1848, an early precursor of the Empire Cotton Growing Corporation, was impressed with the desirability of increasing the efforts, begun as long before as 1788, to develop cotton production in India in competition with America. The long and complicated history of the relations between India and Lancashire is clearly set out down to the revolutionary changes which have followed on the recent war, the implications of which are still in the highest degree uncertain. The questions raised in the final chapter merit careful consideration in this country as in India.

PROBLEMS OF INSECT PESTS OF COTTON IN TROPICAL AFRICA

BY

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(This paper was prepared for the 1948 meeting of the British Association by Mr. Pearson and was read, in an abridged form, to Section D at Brighton on September 10, 1948, by Dr. R. C. Rainey, whose additional note is included.)

THE objects of this paper are to point out the chief insect pests of cotton in tropical Africa, to relate their distribution and importance to the ecology of the crop, and to review some of the problems of their control.

Cotton is grown in three main climatic zones in tropical Africa (see Fig. 1). There are first the semi-arid regions on the southern

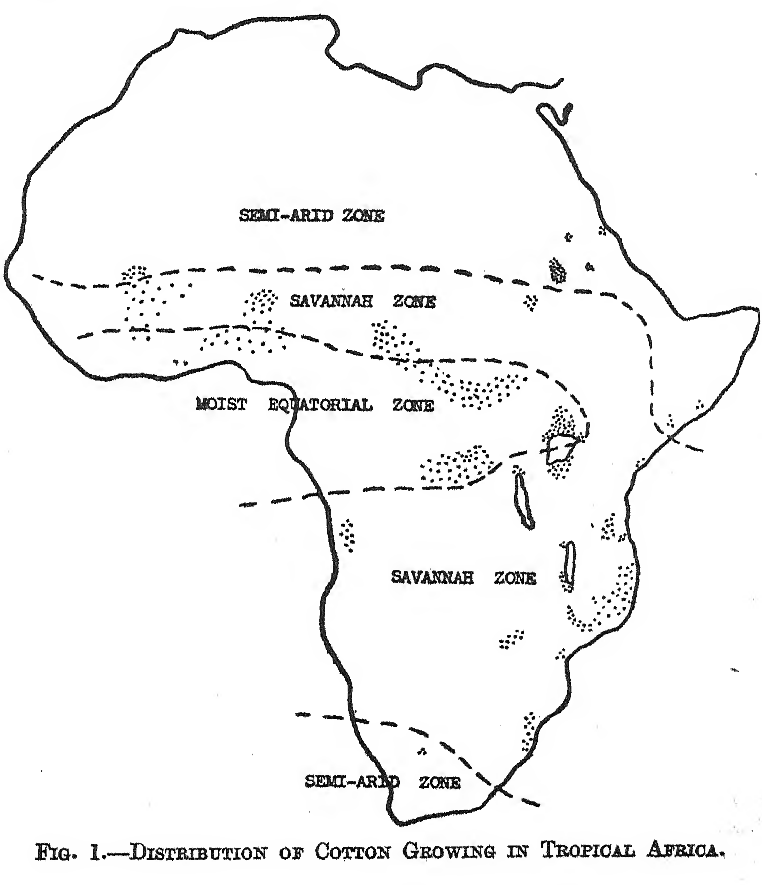

FIG. 1.—DISTRIBUTION OF COTTON GROWING IN TROPICAL AFRICA.

fringe of the Sahara or Libyan deserts where cotton is grown under irrigation. The great plain of the Gezira is the most important of these areas; a similar but as yet much less developed irrigation scheme exists on the Niger in the French Sudan, and in the Gash and Tokar regions of the Sudan cotton is grown on inland deltas relying on seasonal flood water.* All these areas are characterized by centralized control, an intensively organized system of cultivation, and a high level of yields.

The second and the most extensive of the climatic zones in which cotton is grown is that with a monsoon climate, the rainfall varying from about thirty to forty-five inches a year, sharply confined to the hot summer months, the rest of the year being very dry, at first cool and then, just before the break of the rains, becoming often exceedingly hot. In this zone to the north of the equator there is a great cotton-growing belt which stretches through the southern French Sudan and the northern Ivory Coast, northern Nigeria, and the Chad Province of French Equatorial Africa, with an outlier in the province of Kordofan in the Sudan. In the comparable zone south of the equator the cotton-growing areas are more scattered and diversified, because much of this side of the continent consists of plateaux or mountains which are not warm enough for cotton. There are thus the cotton areas of Zululand and the low country of the eastern Transvaal, central Southern Rhodesia, the coastal plains of eastern Tanganyika, the Ruzizi valley in the Congo, at the north end of Lake Tanganyika, and the Lake Province of Tanganyika along the southern margin of Victoria Nyanza. There is a western outlier in Angola. These are the great tree savannah areas of Africa, with a ground cover of grass, and an upper storey which varies from scattered trees, giving a park-like aspect to the landscape, to close woodland or even thicket.

The third climatic zone where cotton is grown is the moist equatorial, characterized by two separate rainy seasons in the year. These regions lie on the outer fringe of the Guinea rain forests, roughly within 5 degrees on either side of the equator, and their vegetation has probably been derived from these forests by the action of fire and cultivation: they are dominated by high grass, with forest relict trees and gallery forest along the watercourses. Cotton is grown in such regions in the southern Ivory Coast and southern Nigeria, the Oubangui Province of French Equatorial Africa, the Equatoria Province of the Anglo-Egyptian Sudan, the Nyanza Province of Kenya, the Belgian Congo and —most important of all—Uganda.

What has just been said gives the picture of the commercial cotton crop as it is today: to appreciate the distribution of insect pests in this

* Cotton was also grown on the irrigation schemes of the Juba and Webbe Shebeli in Somalia, and of the Orange River in South Africa.

it is necessary to know something of the history of cotton in Africa (see Fig. 2); for the whole of the information in the account which follows, I am indebted to J. B. Hutchinson.[1]

Briefly, the situation is that there exist in Africa three indigenous, wild species of *Gossypium*, which have a discontinuous distribution, being found in South-West Africa and also in a long belt just south of the Sahara stretching from Somaliland on the east to the French Sudan

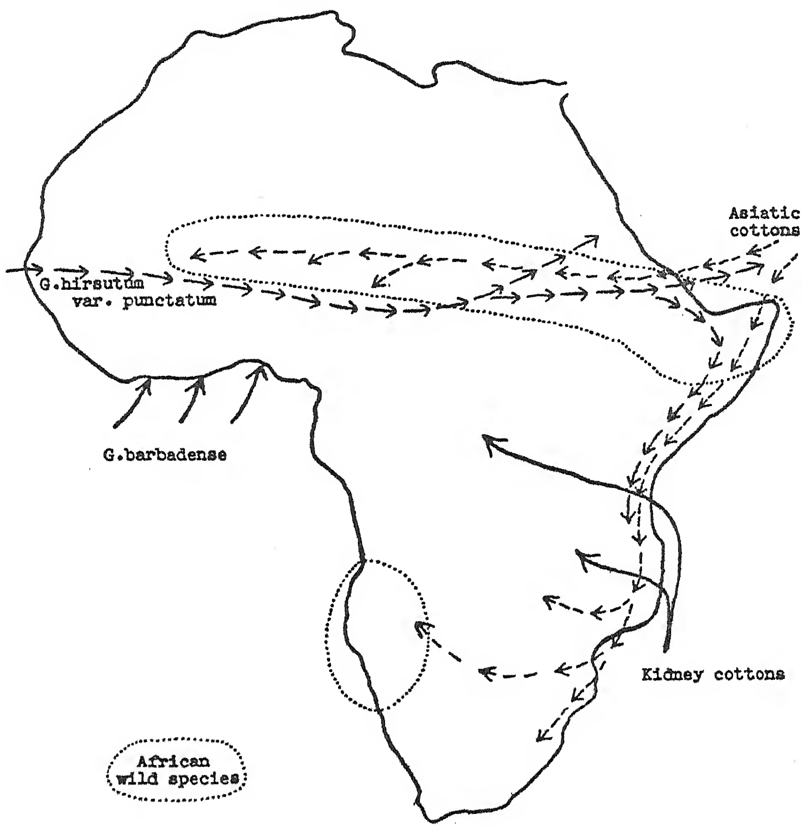

FIG. 2.—DISTRIBUTION OF INDIGENOUS COTTONS AND OF EARLY INTRODUCTIONS FROM THE OLD AND NEW WORLDS. (See Hutchinson, 1947.)

on the west. None of these is cultivated, for none possesses lint hairs: they are, in fact, like the rest of the wild cottons, ancient relic species confined to extremely arid habitats. Africa has been invaded by the linted cottons from the east and also from the west. The oldest cultivated linted cottons are the Asiatic species, brought across from India by man, which have followed two main trade routes, one across the sub-Saharan region and the other down the east coast as far as Zululand, and across the savannah regions to Angola. Today these

are not often cultivated for other than medicinal or fetish purposes, and exist chiefly as perennial commensal plants or wild escapes.

A second and much later invasion came as a result of the first trading and slaving contacts between Africa and the New World and has consisted of the two species which originated in the New World, *G. barbadense* and *G. hirsutum*. The former is the species to which the Egyptian and Sea Island cottons belong, the latter includes the American Upland cottons. Probably the earliest invader was the *punctatum* variety of *G. hirsutum*, which spread right across the sub-Saharan dry belt from the west coast, where it is still extensively cultivated for the native spinning and weaving industry. Another early arrival must have been the coarse linted types of *G. barbadense*, now distributed as commensal cottons throughout the coastal regions of West Africa,* while the so-called kidney cotton, *G. barbadense* var. *brasiliense*, has penetrated right into the heart of Central Africa from both the east and the west coast along the old slave routes. Finally there has been, since the beginning of the present century, the introduction of the American Upland cottons, locally selected derivatives of which now comprise the whole of the rain-grown export cottons of Africa.

It was, therefore, mainly the semi-arid or savannah regions which were first invaded by cultivated cotton, and these were in contact with the very arid areas which are the home of the African wild species. Since the start of cotton growing for export at the beginning of this century, cotton has been carried into much higher rainfall areas than it had existed in before, except for the *G. barbadense* which had been established in the forest regions of the west coast and at isolated points along the slave routes stretching in from the east coast.

The most important fact about the rain-grown cotton crop is that it is almost exclusively grown by African peasants, farmers whose farms are limited to the area of land which can be cultivated by one man and his family. Hired immigrant labour is sometimes used in parts of West Africa and Uganda, and one occasionally finds a kind of collective system in which certain cultivations are done by the whole community, but these are the exceptions. The individual fields of cotton are consequently small, varying between a fraction of an acre and two or three acres. If an area is thickly populated, the whole countryside may be cultivated and the density of cotton may be high, but even so it will be separated by patches of other crops, by homesteads, by uncultivable areas and by resting land. In less densely settled areas the proportion of natural vegetation is greater,

* An interesting recent discovery is that of *G. hirsutum* var. *marie-galante* in the Gold Coast and French West Africa. Evidence suggests an importation from Jamaica by missionaries during the nineteenth century.

and patches of cotton may be relatively isolated amongst surrounding bush. These circumstances have a very important influence on the attacks of insect pests and they will be mentioned again later.

The connection between cotton and peasant farming is an economic one: it is difficult to pick cotton by machinery and consequently a lot of labour is required for harvest, which is a protracted affair. Cheap labour is essential, and it is therefore a crop well suited to the peasant farmer, whose womenfolk and children pick the crop as it ripens. The Upland cotton crop has really always depended upon African labour. In the past the African was taken to the American cotton: latterly the American cotton has been taken to the African.

Cotton is an important crop in tropical Africa from two points of view—as a source of supply of raw cotton, and as a source of wealth to the Africans. The importance of Africa as a source of world supply is perhaps not very great: over the last three years the whole continental production has been fairly steady at 10 per cent. of world production, and only 3 per cent. if the crops of Egypt and the Sudan are excluded. On the other hand, the most important producing countries are also the largest consumers: the United States have of recent years actually consumed more than they produce. So that if we compare the consumption of cotton in the United Kingdom, France, Belgium and Portugal with the production of their dependencies in tropical Africa, including the Sudan, we find that the latter amounts to 30 per cent. of the former. Today, when the countries of Western Europe must depend as much as they can on sources of raw materials in their own economic zones, the importance of cotton from tropical Africa is increasingly emphasized.

If African cotton is of importance to Europe as raw material for her industries, it is of even greater importance to Africans as a source of wealth. In many places, especially in the semi-arid and the savannah regions, cotton is the only export cash crop which the peasant grows, and although in some parts ground-nuts or tobacco may be more valuable, on the whole cotton is of premier importance.

The other export crops of these regions, such as tea, sugar and sisal, are all grown on plantations: they enter into the African's agricultural economy in so far as they provide a market for labour and for local foodstuffs, but they are not directly part of his farming system.

In the moist equatorial regions cotton is perhaps less important—although it dominates parts of Uganda and the Congo. But the other main African cash crops of this zone, notably coffee, cocoa and oil palm products, are all orchard crops, and stand outside the ordinary arable farming activities.

It is these two facts—that cotton is and must be treated as an integral part of the farming system and that it is one of the most (often *the*

most) important cash crops—which set cotton apart and make its problems of such importance to Africa.

That these problems are serious can be realized by comparing the yields of cotton in tropical Africa with those of other cotton-growing countries. The U.S.A. crop today averages something like 250 lb. of lint per acre. Accurate figures for rain-grown cotton in tropical Africa do not exist, but in the best areas such as Uganda the yield is barely half this figure, and over tropical Africa as a whole it probably does not exceed one quarter.

These low yields can be accounted for partly by poor soils and inefficient methods of cultivation. African peasant crops are still largely cultivated by hand, and this makes heavy demands on labour at certain periods. This is especially so in climates with a single rainy season, when the first weedings of food crops coincide with the time when cotton should be cleaned and thinned. The farmer properly thinks first of his food crops, and cotton suffers in consequence.

But apart from purely agricultural factors keeping yields low, there is a very heavy loss from insect pests, greater perhaps than in any other crop. Recent years have seen the development of statistically adequate methods for the estimation not only of pest populations but also of the corresponding crop losses. By such means an investigation, for example, of the shortcomings of the Lower River crop in Nyasaland, variously attributed to almost everything from bad seed to over population, demonstrated clearly that the main trouble was in fact Red bollworm.[2] Several hundred species of insects are recorded as attacking cotton in Africa,[3] but the vast bulk of the damage is due to seven pests and our real problems reduce to the control of these. They are:

The Pink bollworm (*Platyedra gossypiella*), a Tineid.
The American bollworm (*Heliothis armigera*), a Noctuid.
The Red bollworm (*Diparopsis castanea*), also a Noctuid.
All the above are moth larvæ which eat the flower buds and fruit.

The Cotton Stainers (*Dysdercus* spp.), Pyrrhocorid bugs which suck the seeds and green bolls, causing mechanical damage and also transmitting a yeast-like fungus which kills the lint hairs.

Jassids (*Empoasca* spp.), leafhoppers which suck the leaf vessels, causing " Scorch " and checking growth.

Helopeltis sanguineus, a Capsid bug which sucks all green tissues, producing lesions and cankers which stop the plant growing or even kill it.

Lygus vosseleri, also a Capsid, which sucks the very young buds and so prevents the proper formation of leaves and fruit.

The first four are thus pests of the reproductive parts of the plant

and do not affect its structure, the last three attack the vegetative parts and may therefore prevent or delay the formation of fruit. The first two are introduced pests, the rest are species confined to Africa—though some of the genera to which they belong attack cotton elsewhere in the tropics. The present distribution of these major pests is shown in Fig. 3.

The ecology of these insects is interesting as showing the different

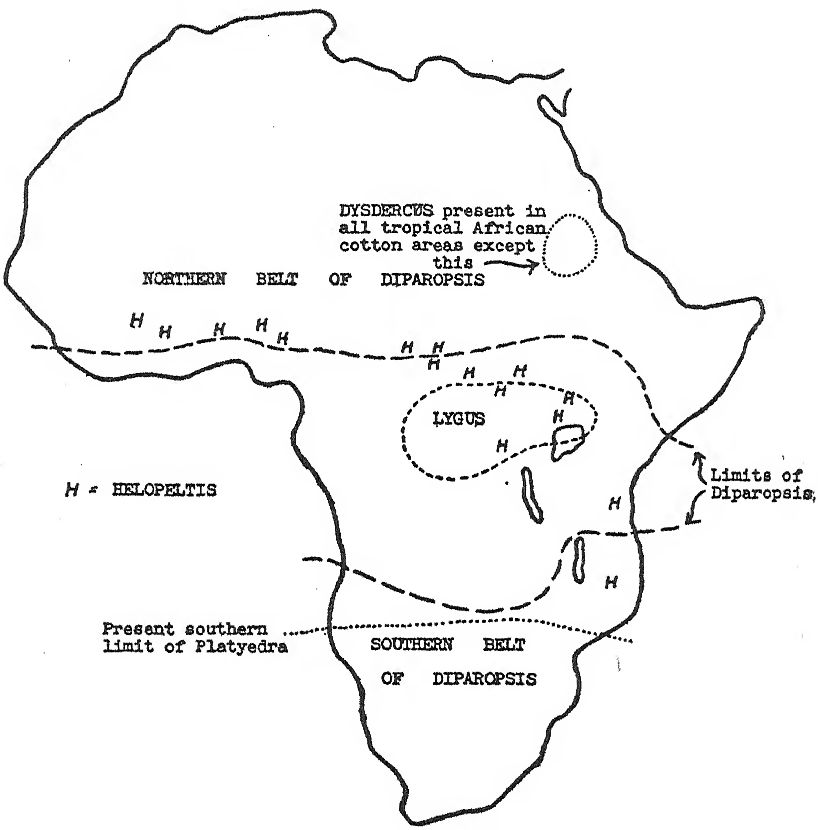

FIG. 3.—DISTRIBUTION OF CHEIF COTTON PESTS IN AFRICA.

ways in which insects can become pests of cultivated plants. Two extremes are illustrated by Pink bollworm and American bollworm. The former is virtually restricted to *Gossypium*. It seems likely that it is indigenous in India, having been primitively associated with the Asiatic cottons, which originated in the Sind province, under a semi-arid climate with a short rainy and a long hot, dry season. Under these conditions *Platyedra* has a larval diapause: this is usually passed inside the hollowed-out seed, and it is an obvious adaptation for spanning a long dry season when the host plant is not fruiting. D—

the value of the diapause was enormously increased when the host plant became domesticated and its seed started to be carried by man. The insect has now spread with seed to almost every part of the world where cotton is grown, and in Africa only the Union and the Rhodesias are still free. This extraordinary success thus depends on a very close adaptation to cotton and to the conditions under which primitive cottons existed.

An example of precisely opposite reasons for success is shown by the American bollworm, *Heliothis armigera,* whose status as one of the most widely distributed of all pests is due, not to any close adaptation to one genus, but on the contrary, to its ability to breed on a very large number of hosts, including many of the most important crop plants.

The other five pests are all wholly African species. The Red bollworm, *Diparopsis,* has, like *Platyedra,* a very limited host range. It only breeds on *Gossypium,* on the closely related *Cienfugosia,* and, less freely, on *Gossypioides kirkii,* also a near relative. The African wild species of cotton occur in such unfrequented places that their insect fauna is still unknown, but the distribution and habits of *Diparopsis* suggest that wild cottons may be its original hosts.

Diparopsis has a discontinuous distribution. It is almost entirely absent from the equatorial zone, but it occurs in the semi-arid regions, and in the savannah regions with a well-marked dry season, both north and south of the equator. It is very well adapted to this type of climate, for the dry season is passed as a long-term pupa, formed in an earthen cell in the ground. One may suppose that it moved first from its primitive, indigenous host plants to the earliest-introduced linted cottons, namely the Asiatic species brought from India, and spread amongst these across the sub-Saharan zone and also across the southern dry savannahs. Its present importance as a pest is because modern commercial cultivation has been taken actually into, or into contact with, the areas where the insect was already living and to which it was highly adapted. Red bollworm is thus important right across the sub-Saharan and savannah belt of the northern hemisphere and, in the southern hemisphere, from Angola on the west to Mozambique on the east, and in the territories south of these.

Under the more equable conditions of the moist equatorial zone, *Diparopsis* does not form resting pupæ and consequently depends on a continuous food supply. In West Africa the New World cottons have been long and widely established as perennial crops, the *punctatum* spreading down from the north to meet the *barbadense* types coming up from the coast. This chain of perennial cottons has allowed Red bollworm to break out of its original semi-arid areas and come down, even in the absence of a long-term pupal stage, to the moist equatorial

regions. In East and Central Africa the perennial cottons have never been widely enough cultivated to allow the infiltration of *Diparopsis* into the moist equatorial zone;* the expansion of cotton cultivation in the present century has been entirely of annual crops, and the combination of the close season with the absence of long-term pupæ has prevented the insect's survival.

The remaining four pests are all *Hemiptera*: they have no resting stage and therefore depend on continuous supplies of food and moisture. Of these the Cotton Stainer, *Dysdercus*, is the most widely spread of all the African pests. This genus has a world-wide distribution in the tropics in association with plants of the order *Malvales*, on whose seeds they feed and which are essential to their breeding. Cotton belongs, of course, to this order, and it is therefore commonly invaded by stainer populations derived from the wild host plants. These include several common weeds of cultivation and a very large range of herbs and trees, many of which are specially abundant in the savannah regions. There are half a dozen species of cotton stainer of importance in Africa, all confined to that continent, and all with different climate and host preferences which determine their distribution and their importance as pests.

Lastly there is the group of pests which attack the vegetative parts of the plant, of which those most widely distributed in Africa are the leafhoppers of the genus *Empoasca*. These jassids attack cotton elsewhere in the tropics, but the African species are indigenous and have a number of hosts amongst the *Malvaceæ* and other families. They damage the leaves of cotton by feeding on the vessels and interfering with the transport of plant foods. They tend to be more numerous, and their damaging effect more severe, when the plant is living under difficult conditions, so that they are pre-eminently pests of the semi-arid or savannah zones. In the moist equatorial zone, and especially in the extreme form of this—that is, the Belgian Congo and the Guinea forests—they are not serious pests.

The other two pests have an exactly opposite distribution. Broadly speaking, *Helopeltis* and *Lygus* are pests of cotton in the moist equatorial zone, although both of them do occur where higher altitude and rainfall create special conditions outside it. Neither cotton nor genera closely related to it occur naturally in this region, and neither of these Capsids is therefore pre-adapted to cotton, nor, indeed, do they breed particularly freely on it. They seem to include it, as it were, accidentally in their food range, and their physiological connection

* Recent investigations in Southern Tanganyika suggest that there may be a danger of *Diparopsis* moving into cotton in that area via *Gossypioides kirkii*, which occurs in a very narrow strip along the east coast of Africa from Kenya to Zululand, and on which *Diparopsis* has been found breeding, though in exceedingly small numbers (Author's note, January 1949).

with it has not yet been studied. Comparatively little is known about *Helopeltis sanguineus*: it attacks a large number of plants unrelated to cotton, and closely related species attack cocoa and tea. *Helopeltis* feeds on green tissues, the saliva setting up an intense reaction, producing cankerous lesions, and sometimes killing the plant. Broadly speaking, *Helopeltis* is associated with secondary tree savannah derived from tropical forest: it is not found in dry savannah or more arid types, nor to any great extent in the purer grasslands. Its peculiarity is that its appearances are very sporadic: but every few years sees a really devastating outbreak.

The other Capsid, *Lygus vosseleri*, also a purely African species, has a still more restricted range. It is predominantly a pest of cotton grown towards the upper limits of altitude of the crop in the moist equatorial zone, that is, in the grass savannahs of the eastern Congo and Uganda, at altitudes of 3,000 to 4,000 feet. Under the warmer conditions of lower altitudes, in the moist equatorial zone, as for example in West Africa, it is not a serious pest. Its range of host plants is incompletely known, but the most important, from a practical point of view, are *Eleusine*, or finger millet, and *Sorghum*, which are staple food crops. Under certain circumstances these build up very large populations of *Lygus* which disperse to cotton when the grain is harvested. Elsewhere a reservoir of infestation is provided by some of the common weeds of cultivation or of resting land. On cotton, *Lygus* feeds exclusively on the very young bud tissues, causing a reduction of the leaf surface and, in severe attacks, wholesale distortion of the plant structure. It remains for the physiologists to explain the connection between this feeding habit on cotton, and a diet of developing grain on the main hosts.

I want to follow this very much compressed review of what the chief pests are, and how they arise and are distributed, by dealing briefly with the problems of their control.

Jassids might be taken first, because they have been, or can be, most satisfactorily controlled. It has been known empirically for many years that hairy varieties of cotton are less attacked by jassid, and it has recently been shown that the size of the jassid population is inversely correlated with the length and the density of the hairs on the leaf surface.[4] It is significant that the wild cottons, and also the semi-wild Asiatic species of the drier savannah areas, are all strongly pubescent. The success of commercial cotton growing in the dry savannah areas depends entirely on the use of hairy varieties, and the plant breeders' task—which has been largely achieved—has been to produce these. The Egyptian types of *Gossypium barbadense* grown in the Sudan are rather a different case. These do well, although they are almost glabrous, possibly because their foliage is in some

way tougher than that of Upland cottons, and also because, being grown under irrigation, they do not suffer the same water-strain as the crops of the savannah regions, where the rainfall is uncertain. Nevertheless, jassid attack is nowadays recognized as serious in the northern Gezira, and here the unusually favourable conditions of large-scale plantation farming have allowed the only successful commercial use, to date, of insecticides on cotton in Africa. Even here it is likely that transference of major genes for hairiness will eventually give a permanent and cheaper solution.

I want now to consider the cases of the Pink bollworm and the Red bollworm—both practically limited to cotton as a host, and both equipped with resting stages in the life cycle. In the former, *Platyedra*, the very closeness of the adaptation which has enabled the pest to spread has also exposed it to the possibility of control. The larval diapause is induced by high temperature and low humidity, and in the semi-arid Sudan and the savannah regions of the West African cotton-growing countries, *Platyedra* normally spans the dead season as a resting larva inside the seed. Control therefore depends upon seed treatment, which is a relatively simple matter where the whole crop passes through ginning factories. Machinery can be used there to raise the temperature of the seed to such a degree as will kill any larvæ inside without affecting germinating capacity. Efficiency of control depends on the whole crop actually reaching the ginnery: where a flourishing hand-spinning industry exists, dependent on hand ginning, control breaks down.

In the regions with a less extreme climate, notably the equatorial zone, control is effected by a double change from the original conditions to which Pink bollworm was adapted. The diapause is not induced, so that the insect can only survive by means of a succession of short-term generations, and this has been made impossible by the substitution of the annual for the perennial habit of growth in the cultivated cottons.

Such controls as exist for Red bollworm also depend on manipulating the time and length of the growing season so as to limit the production and the survival of long-term pupæ. Complete control can be got where, as in the Sudan or in northern Nyasaland, the use of irrigation or controlled flooding enables one to delay planting until after the time that the last of the long-term pupæ have emerged. This method could be used on the Niger scheme in the French Sudan, and also in the Shire Valley of Nyasaland if river control proves feasible there.

A quite different approach—that of growing cotton in the climatic conditions which only allow short-term pupæ to be produced, coupled with a strict close season—is, in effect, in operation in the central and

east African moist equatorial regions, from which Red bollworm is thus excluded, in contrast to West Africa, where perennial cottons enable it to flourish. To confine crop production to the moist, equable portion of the year in a strongly marked monsoon climate is a much more difficult job, because it results in cotton competing with food crops for the producer's labour at critical times of the year. In most of its range Red bollworm is therefore very hard to control.

The problems just dealt with are to some extent simplified because both the bollworms are confined to cotton. We now face the more complicated cases of pests with many other hosts, amongst which is the American bollworm, *Heliothis*. This owes its success to its ability to breed on a range of hosts which includes many of the most important crop plants, but it is possible to turn this to account in controlling the pest. *Heliothis* larvæ need to feed on a succession of developing fruits, and egg-laying consequently coincides with flower production. Not all crops, however, are equally attractive, and cotton is not one of the most favoured. Consequently serious infestations only occur on cotton when there is a gap in the succession of more favoured plants. For this reason, *Heliothis* is usually most serious in places like Texas, South Africa, or the Rhodesias, where large-scale farming is carried on, involving big areas of—particularly—maize and cotton planted about the same time. The maize flowers first and produces a generation which then invades the cotton. Cotton can, however, be pretty well protected by suitably timed successions of maize and leguminous crops. This may be why, under African peasant farming, where the numbers of crops, and their dates of planting, are greatly diversified, this pest is much less troublesome, and epidemics rare.

Problems of even greater complexity are presented by cotton stainers. These also depend on the place of cotton in the sequence of other food plants, and in the case of *Dysdercus* these are wild hosts, instead of cultivated ones, and consequently involve studies of the ecology of the natural vegetation, and of stainer populations in it. These populations show a strong tendency to disperse from their breeding site when they reach maturity, a tendency which is of course intensified if those sites at the same time are becoming unfavourable, either through lack of food or lack of cover. Where such a gap in the wild host sequence is filled by cotton, the latter is invaded. Often this invasion does not come until the first bolls are opening, in which case control depends on producing, by agricultural and plant breeding methods, a crop which matures most of its bolls in a limited time, so that they will pass through the early stages when they are most susceptible to the disease carried by stainer, before the latter have had time to multiply within the crop.

The magnitude of the stainer invasion depends on the crop area in

relation to the size and proximity of the wild host populations. Stainers are therefore usually least serious in places where the density of cotton growing is very high, and worst in places where cotton growing is still in the experimental stage. The remedy for serious stainer damage in cotton is thus, in a sense, to grow more of it. But in several parts of Africa it has been found that the host sequence is such that cotton is bound to be invaded at an early, susceptible stage, so that one has either to avoid such places or attempt to eradicate their wild host population.

In the case of *Helopeltis*, partly because its outbreaks are sporadic and partly because it has a very limited distribution in the main cotton areas of the British territories, we lack the detailed knowledge that we have of other pests. But over very large tracts of the North Congo, French Equatorial and French West Africa, it is extremely serious, and work on it is urgently needed.

Finally we come to *Lygus*, whose distribution is limited but which is of such great importance because it affects the Uganda and, to a less extent, the Congo crop. Here again it has been suggested that crop timing may give a chance of control: early planted cotton tends to be invaded at an early and susceptible stage by *Lygus* populations derived, in certain areas, from weeds of the grass fallows and, in others, from the maturing grain crops grown in the first rainy season. Early plantings, despite *Lygus* attack, eventually give bigger yields of the varieties at present grown, but it is possible that one could breed shorter-term varieties, suitable for later planting, and avoiding insect attack. These would probably fit in better to the farming system. Our principal need is for more information on the bionomics of *Lygus* under different conditions.

In this review of cotton pest problems emphasis has been laid on control methods which depend on detailed knowledge of the ecology of the pests and their wild and cultivated hosts, and on the place of the latter in the farming system. This knowledge is fundamental to a proper attack on the pests, from whatever angle.

But there are evidently strict limits to the use of "control by evasion," limits imposed by the place of cotton in systems of African peasant farming. It is becoming increasingly clear that we have got to look to other methods. The first is the search for resistance, which requires the testing not only of different varieties already in cultivation, but the examination of the primitive wild species and of the reservoir of genes, so far only partially tapped, which may exist in the centres of variability of the prototypes of the cultivated New World cottons. Thanks to the work of the geneticists, this material can now be explored in an orderly and informed manner. The search for resistance will involve both direct tests and more indirect physiological studies.

The second method is that of direct action by insecticides. So far these have been little used because of their limitations in African peasant farming. DDT has been successfully used on cotton in the Sudan because the crop there has an intrinsically high yield and value, and because its cultivation is so efficiently organized that spraying costs can be kept low. There are urgent economic and political reasons for accelerating the transformation of African peasant farming. One method exists in the development of mechanical cultivation on a contract or a co-operative basis, thereby automatically giving a more orderly, regular arrangement of land units, a better control of time of cropping, and the possibility of organizing insecticidal treatments and even of carrying them out mechanically. I think the next few years may see big changes on these lines, and work on the technique of using insecticides under the usually very difficult conditions of the tropics must be pushed on to be prepared for it. There are already encouraging preliminary results from this work.

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In addition to the above, I have drawn freely upon the results of observations, largely unpublished, made during the course of travels which have covered all the principal cotton-growing areas of tropical Africa in the last few years, and upon research work recorded in the Empire Cotton Growing Corporation Reports from Experiment Stations, and ancillary papers, carried out by our staff over the past twenty years. I should like to express my thanks to my colleague, Dr. Rainey, who at very short notice took over the task of editing and abridging this paper and delivering it to the British Association meeting, which I was prevented from attending by my recall to Uganda.—E. O. P.

Additional Note by Dr. R. C. Rainey

The problem to which I personally should like to draw attention is the search for resistant varieties. This method of control has already been outstandingly successful in dealing with jassid in southern and eastern Africa, and is likely to deal similarly with blackarm, a bacterial disease, in the Sudan. It must be admitted that neither of these examples owes much to entomologists or bacteriologists; resistance was in fact stumbled on practically ready made, and brilliantly exploited by the plant breeders at Barberton and the geneticists at Shambat. The methods used depend in the case of the bacterial disease on the development of a satisfactory field method of uniform mass inoculation (which is difficult to envisage for insects), and in the

case of the jassid on the discovery of a measurable plant character (leaf hairs) which provides an accurate estimate of its resistance.

I suggest that detailed studies of the relationship between the plant and other pests and diseases might demonstrate other less obvious factors associated with resistance and susceptibility. Besides direct observations on the widest possible range of wild and cultivated cotton, indirect methods also show some promise. Thus, for example, the cotton boll shows marked changes in susceptibility to pests and diseases in the course of its development; and it has been found that attack by the fungus *Nematospora* is most damaging at the stage which is richest in sugars, while young bollworms of all the species appear to feed selectively upon the stages which represent the richest source of protein available to them. We cannot, of course, ask the plant breeder to produce cotton bolls deficient in that sugar or protein; but, where pests and diseases are limiting factors of such importance to the development not only of a single crop but of whole African territories, an analysis of factors affecting resistance might well produce results comparable with those given by the chemical studies of factors affecting yield.

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AGRICULTURE IN ITS WORLD SETTING

BY

H. MARTIN-LEAKE, Sc.D.

A REVOLUTION is taking place in the general outlook towards the position of agriculture in the world's economy, and it is a revolution of which those directly interested in agricultural production must take cognizance, for an interdependence is creeping into the demand for the different forms of produce which will soon not allow the production of one class to proceed without regard to its relation to total production. That fact is, as yet, little appreciated among primary producers and still less among peoples generally. In the latter case, the reason is obvious; the industrial element which constitutes the voiceful and politically active section of the population, does not look beyond the shop and, at most, attributes the bare shelves to the war. In the former case, producers, particularly producers of perishable goods, even now find their market at times glutted. Nor does this apply only to perishable produce; sugar and coffee between the wars bear witness. The specialization which has crept into agriculture masks the broad trend. That trend results from the world's increasing population combined with the desire for a rising standard of living in vast masses of people, and a growing scarcity of land available for easy agricultural development such as the vast spaces of North America offered in the last century.

It is not within the scope of the present article to discuss the population problem further than to emphasize its over-riding importance, an importance which all the warnings of the F.A.O., of its recent leader, Sir John Boyd Orr, and of such books as P. B. Sears' *Deserts on the March* and W. Vogt's *Road to Survival*, have failed to bring home. At present, little more than lip service is paid by those in authority to these warnings, and signs are not wanting that even this is being replaced by a growing complacency that, with the better prospects due to recent good harvests, the food situation is solved. If individual memories are short, group memories are long, and the conditions which prevailed in the thirties have not been forgotten. Those conditions justified the comment, " the superabundance of agricultural produce of all sorts with which the world is at the moment cluttered up . . ."* and still influence thought—the saving words " at the moment " were inserted as an instinctive rather than a deliberate response by one who served his apprenticeship at a time when Malthus and Darwin formed

* H. M.-L. in *Empire Cotton Growing Review*, 1936, XIII, p. 31.

an integral part of a biological curriculum and who recalls the forebodings of Sir William Crookes at the end of last century.

Nor is this the place to do more than emphasize that second factor, the desire for a higher standard of living, called into being by education and the spread of knowledge as to how others live and intensified by mass movements during the war. There can be no peace where the deficiencies in the basic necessities for an acceptable standard of life—the prime of which is food—are realized; and it is only too easy for those who suffer to cast the blame for these deficiencies on some other group. In the early twenties, as an emotional response to the pitiable intensity of child mortality in India, a child welfare organization was inaugurated, and the present writer incurred some odium through his refusal of support unless that movement was accompanied by a movement as intense to limit the birth rate. Not only has India (with Pakistan) increased her population from 300 to 400 million in 50 years (in spite of the loss of nearly a decennial increase through the influenza epidemic of 1918) as the result of failure to control her birth rate whilst reducing child mortality, but she protects her aged and uneconomic cattle, causing a further drain on her food supplies. This story is being repeated everywhere. In the West Indies, with an economy based on agriculture and few openings for emigration, is to be seen the same vain attempt to secure a higher standard of living than the productive capacity can support. Here, proposals such as those the recent Royal Commission have propounded can be but palliatives. A birth rate that is based on geometrical progression is insatiable.

These fundamental questions are mentioned here only because they provide the background against which the agricultural problems must be viewed. One further explanatory comment may, however, be made. It is significant that that vague process which is termed civilization, and the outward characteristic of which is a high material standard of living, has as its accompaniment a reduced birth rate, leading to a stable and even decreasing population. That change has been brought about in the western world without crisis through the opening up of the vast undeveloped spaces of the western Continent. Thence has been drawn the wherewithal to meet the growing but incrementally diminishing needs. There are no longer such fresh areas, and the question arises whether resources can be increased at a rate which will admit of the raising of the standard of living of those hordes of economically backward peoples while those same restrictive forces on human fertility gain effectiveness. That is a question of time and, if time be inadequate, the cruder forces of nature, famine, pestilence and war will be the agents of adjustment.

This problem is not merely one for agriculture. If the products of the soil supply the ordinary needs of man, hardly less important for civilized

life are sources of power. Until the problem of the harnessing of atomic energy is solved, these sources are four: water, coal, oil and alcohol. Water is a localized source; coal and oil are capital sources, the locked-up energy of past ages, and it is not possible to live on capital for ever. Alcohol is a revenue source, but, being the product of living vegetation, its production is in direct competition for the land on which the primary needs of man are raised. The position has been summed up by H. L. Lyon in his statement* that, if all the fermentable crop products grown in the States were used to produce alcohol, the yield would be less than 10 billion gallons, less than half in volume and with considerably less energy per gallon than the present U.S. consumption of gasolene. But 80 per cent. of these crops were even then required for food. There is little justification for rosy optimism here.

That is the background against which the agricultural problem must be set and considered. There not only is, but will continue to be, an insistent demand for increasing supplies of agricultural produce. It may well be that times will occur when a run of favourable seasons will mask this demand, and occasions when it will be true again to speak of "the superabundance with which the world is at the moment cluttered up," but such occasions will be the consequence of man's folly in allowing finance to be his master and not his servant. The catastrophe which must eventuate if population increase is not brought under control can be avoided only by a rise in the volume of agricultural produce. It is this agricultural aspect that it is proposed to discuss here.

There are, at first sight, two means of attaining the objective. The area under crops and pasture can be expanded, or the production per unit area (yield per acre) may be increased. But the problem is not so simple as that. Through man's improvidence, already vast areas have been mined instead of cultivated, with the partial and even complete destruction of fertility. On that aspect it is not necessary to enlarge here; it has been sufficiently emphasized by G. V. Jacks and R. O. Whyte in *The Rape of the Earth.* The dangers from erosion through mishandling of the soil have come to be recognized, but it will be long before the problems of conservation, and still longer before the more difficult problems of reclamation are solved.

There is, however, a more subtle agency at work which has been generally overlooked and, where recognized, appears to be accepted as inevitable. Modern methods of plant breeding encouraged the hope that varieties with a higher yield potential than that of the long-established "land sorts" would be forthcoming. That hope has, in fact, been realized; for instance, the introductions of new varieties of sugar cane bred in Hawaii, Java, India, the West Indies and elsewhere, have vastly increased yields. But, in practice, it has been found that the

* *Hawaiian Planters' Record,* 1942, 46, p. 1.

duration of life of these new varieties is brief: some 10 to 15 years. They " run out," whereas older varieties such as the indigenous Indian canes have not exhibited the phenomenon. The sugar is here chosen as an example because the so-called " varieties " are clones, vegetatively reproduced, and, therefore, static. It is not in the variety, but in the cultural conditions as these affect the soil, that the dynamism which is the cause of the phenomenon of " running out " must be sought. Further proof of this fact is to be found in the history of the old Otaheite cane. This variety still retains its vigour in certain areas of the New World after the centuries since its introduction, but has succumbed to disease in the main sugar tracts of the States. Yet this logical conclusion has hardly been drawn; efforts are concentrated on raising a constant stream of new " varieties " to take the place of their predecessors as these " run out." The following quotation, taken from a recent bulletin on the mosaic of the sugar cane,* illustrates the point:

" The constant stream of new hybrid varieties resulting from crosses made at Canal Point and satellite sub-stations (sometimes requiring shipment of pollen by airplane) has become a necessity recognized by cane growers. They, *as well as the specialists working on field production problems*, are coming more and more to the realization that the environment in which the crop is produced is not static but dynamic, presenting in every field an ever-shifting picture of varying soil composition and texture, weed populations, water relationships and other changing factors, including the character and abundance of pathogens, such as strains of mosaic virus. In contrast the individual variety or vegetatively propagated clone is static. . . ."

It is difficult to harmonize this with concentration on varietal breeding. Soil dynamism is surely worthy of more attention than has yet been given to it, for it is a negative dynamism, as surely, if not as evidently, leading to loss of fertility and, ultimately, sterility, as the more prominent agency of erosion. To rely on varietal substitution is to enter on a vain race.

Since the meeting of the ultimate needs of a world population continuing to increase at its present rate is out of the question, the problem that faces agriculture is to provide that steady rise in production which will permit the attainment of that higher standard of life which will, given time, lead to stability in that population. In considering how this may be achieved, it is not only the increase in area and/or in yield that must be discussed, not only conservation and reclamation, but the cause of that more subtle loss of fertility of which the need for continued varietal substitution, exemplified in the case of sugar cane quoted, is merely an indication.

The land surface of the globe is limited and the extent of that surface

* *Tech. Bull.*, 955, U.S. Dept. of Agric.

which can be brought under cultivation, both arable and pastoral, is even more restricted. Mountains, arctic regions, deserts and man's requirements for dwelling and communication occupy no inconsiderable area. His demand for timber and wood-pulp already outstrips regeneration and the shrinkage of forests has been the primary cause of much erosion. But there are still further limits. The possibility of a permanent agricultural system is dictated by climate and, particularly, rainfall. In one direction lie the marginal lands due to deficient rainfall and high temperature. On these, nature has established a stable but delicately balanced life, and any disturbance of that balance, such as over-grazing, is likely to be disastrous. Thus arose the American "dust bowl." In the other direction, in areas of high rainfall and high temperature, she has developed vast tropical rain forests. Agriculture as generally conceived is concerned with attempts to make good the deficiencies in factors below the physiological optimum; it has yet to be realized that, as pointed out by J. Henry,* areas exist where the physiological optimum is exceeded. Such are these forests. The canopy here protects the soil and supplies to it a wealth of humic material which suggests an inexhaustible fertility. But these appearances are deceptive. Remove the canopy and that fertility vanishes; rapid disintegration of humic material takes place and the direct impact of rain leaches out the available plant food. There is small opening for a permanent system of agriculture here; the primitive methods of shifting cultivation bear witness. With the exclusion of these extremes, the potential areas for permanent development can constitute but a partial easement. Details are given, continent by continent, by W. Vogt, while the potentialities of Africa, the hope of so many, are sufficiently summed up in the title of an earlier well-documented book, *Afrique, Terre qui Meurt.*†

If the opening of new areas offers only temporary easement, what are the potentialities of increased yield? Here the limit is imposed by what the agrobiologists term the "quantity of life" inherent in any particular variety. When all external limiting factors to growth are removed, the wheat plant will never attain the size of the bamboo; growth is ultimately limited by factors within the organism. Methods have been evolved by which the "quantity of life" of many varieties of cultivated plants has been measured with reasonable accuracy. In few cases do yields under field conditions exceed 20 per cent. of the maximum. Here there would appear to be a vast reserve from which the growing needs can be met, with a further margin from the breeding of varieties possessing even larger "quantities of life." But the external limiting factors are many, and chief among these is the solar energy

* *Empire Cotton Growing Review*, 1949, XXVI, p. 5.
† *Afrique, Terrequi Meurt*, Jean-Paul Harroy, Brussels, 1944.

available to the assimilating tissues. Many of these factors are not, or are only partially, controllable by man, whose plant breeding efforts are mainly directed to the production of varieties less susceptible to the uncontrollable factors. Some measure of the problem is given by the range of varieties found in so many species of cultivated crops and breeds of stock, each adapted to a relatively narrow range. In the case of those factors more readily controlled by man, such as the elements of plant food used to measure the " quantity of life," there is an economic limit imposed by the law of diminishing returns; for, by definition, the Baule unit is that which gives, for each additional unit, an increased return equal to half the return given by the previous unit. From these considerations two conclusions may be drawn: yields corresponding to any more efficient use of the " quantity of life " than is already obtained by good husbandry are unlikely to be reached and the breeding of varieties with a greater " quantity of life " is likely to be unprofitable.

There remains for consideration that dynamism in the soil to which reference has been made above and of which the " running out " of vegetatively reproduced plants is merely an indication. Characteristic of that degenerative process is susceptibility to disease, and it is beyond question that diseases and pests are taking a growing toll of both agricultural plant and animal life. It is unfortunate that major attention has been given to the control of the attacking organisms rather than to tracing the causes of this degeneration. There is adequate evidence to justify the view that these harmful results flow from an over-simplification of the plant-soil relationship. A severely limited outlook, originating in the work of Liebig, has developed a system which relies on the provision of the requirement of plant food in inorganic form. Life does not work by such simple means. If the complex processes of plant nutrition are not fully understood, it is because an outlook, hardening through the generations which have inherited the Liebig tradition, is not easily changed. Soil is not an inert body; it teems with life and for that life humus is essential. Quantity may, for a time, be obtained from inorganic fertilizers, but it is bulk lacking the vigour of real health which imparts resistance to disease. The rôle of humus in its physical effects is, perhaps, admitted; its biological rôle is, as yet, hardly recognized. On such faulty bases are vast schemes for agricultural development being based. In the original plan for the groundnut scheme in East Africa, organic matter is considered solely as a means of increasing the water-retaining capacity of the soil. It is, moreoever, to be incorporated " deeply into the soil," thus subjecting it to anaerobic in place of the desirable aerobic fermentation. Compare this outlook with that of the late G. Clarke, who succeeded in maintaining thrice the former yield of sugar

cane and nearly thrice that of wheat in the Gangetic plains of India. He wrote:*

"This result depended on raising to, and maintaining at a higher level, the balance between soil aeration, organic matter and variety. Short cuts to increased production which give rise to unbalanced soil conditions, such, for example, as the excessive use of artificial nitrogenous manures, under the conditions which prevail in the United Provinces are attended by the gravest risks. Irreparable damage can be done to the magnificent soil which for thousands of years has been the wealth of India. Its recuperative power, namely, its power to fix nitrogen by non-symbiotic processes which is increased by rational methods of intensive cultivation, will be destroyed and more and more artificials will have to be used. A state of affairs will inevitably arise in which the active soil organic matter will be used up during the attempts of the organisms to deal with unnecessary nitrogen. Desert conditions will make their appearance, accompanied by alkalis which will put a stop to cultivation of any kind."

Those words were written of the Gangetic plains, but they have a general application. Clarke was born and bred on a Lincolnshire fen farm and elsewhere he attributes his interpretation of the Gangetic soils to experience on the fen soils. That warning should be taken to heart. Economic conditions in those areas compel the burning of animal residues as fuel, and humus is the crying need. Improved varieties alone can effect little. By 1910, varieties of wheat had been introduced capable of doubling and even trebling the yield; yet the quinquennial yield for 1935-39 was slightly below that for 1896-1900. It is in the humus status of the soil that is to be found the explanation of the dynamism which is destructive of fertility and of the lack of health which renders the plant a prey to pests and diseases. It is here that India can find temporary relief for her teeming millions while she is bringing under control her population problem. Any large use of her potential hydro-electric power for the production of nitrogenous fertilizer must lead to disaster. It is encouraging to find that she has latterly developed an active organization for the purpose of converting all human wastes, both of town and country, into compost for return to the land. In this she is associated with South Africa, Salvador and Costa Rica. By attention to the humus status of the soil more than to any other single factor, the human race will gain time for the readjustment of its population problem—if it learns to realize the existence of that problem.

Under the conditions described, there must be a growing pressure on the land, though the fact may well be masked by periods when financial maladjustments give the appearance of gluts. Nor is the date

* Personal MS. bequeathed to the present writer.

so distant that the problems raised can be safely ignored. Crop will compete with crop for the available area, and arable with pasture. What will be the position of cotton under these conditions? Ultimately, pride of place will be given to those crops which provide the primary essential for man's existence, food; under the pressure of war, England has already met that experience. More immediately it is the net economic return that will decide the area devoted to any crop. The possibilities of securing an increased return from the unit area form, therefore, a subject worthy of serious consideration. Lint, both in quantity and quality, offers one means which has always been recognized; but has sufficient attention been given to the plant's potentialities in regard to oil and protein? S. C. Harland has shown, in Peru, the latent capacity to yield oil. Again, Africa has long been regarded as an area from which substantial supplies might be drawn, but, except for the Sudan, Uganda and, to a lesser extent, West Africa, expectations have not been realized; the vast expanses of East Africa have yielded only a small response. Basically, the reason is that the New World cottons are ill adapted to the continental climate of these areas, which are better suited to those of the Old World. It is a choice between quality and "hardiness"; cannot these two characters be combined? It is a problem of securing fertility in a cross between two species having chromosome numbers $n=26$ and $n=13$ respectively. That is difficult but not impossible, as S. C. Harland, again, has demonstrated. It is a line of investigation worth following up.

The economic problems here raised have another aspect. Cotton is a short-term crop, one in a rotation. The labour involved in picking renders it unsuitable for plantations and it is essentially a crop for peasants. There is involved the question of how technical control, the organization of seed supply, the regulation of cultivation and the grading, processing and marketing of the crop, can be exercised under a peasant system without a dictation which is the antithesis of the basic policy of social advancement. A plantation basis is undoubtedly the simplest method of exercising such control, but, as is becoming evident, most clearly in the case of the cane sugar industry, it is a precarious basis. Plantation labour is in a position to be intransigent, for by strikes it can hold the whole industry to ransom. Still less is a Government organization, whether directly or indirectly sponsored and financed, a suitable agent. Government, under such conditions, becomes an interested party, incapable of impartial intervention. There is only one answer to this problem. It is the privately financed Agricultural Co-partnership Association, not owning the land but controlling production over a given area under a licence from Government with predetermined conditions guarding the interests of the peasantry. Cultivable land would be held under tenancies conforming as closely as

possible with local custom but with the minimum of control to assure good cultivation, and the produce from cash crops handled centrally with payment on a co-partnership basis. The system can only thus far be outlined here; it has been described in greater detail elsewhere.* It is sufficient to say that this is no visionary scheme. Such organizations are in operation both in the Sudan and Fiji. In both cases its adoption arose from the abnormally adverse conditions; both were the brilliant improvisations of men of vision, and both have proved successful. Errors have been made—under improvisation they were inevitable—but the experience gained, combined with the fuller knowledge now available of the principles of co-partnership, provides invaluable material for future guidance. Only on such a basis can the growing needs for increased production be met with due regard to harmony in social advancement, for the organization provides within itself the means of satisfying the ambitious and of gaining that experience which will ultimately allow control to pass into responsible and well-tested local hands.

* H. M.-L., *Unity, National and Imperial.*

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THE ZANDE SCHEME

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INTRODUCTION

THE south-west corner of the Anglo-Egyptian Sudan is inhabited by the Azande—a near Bantu tribe of mixed origin. It was for the social and economic development of this tribe that the "Zande Scheme" was planned.

A proportion of the Azande live in the Belgian Congo and French Equatorial Africa, but the Zande Scheme described is a Sudan project only. The Zande district of the Sudan comprises some 20,000 square miles of undulating plateau country in the Nile Congo watershed region to the east and south of the point where the boundary of the French and Belgian territories meets that of the Sudan. Yambio is the headquarters of the district, and is now the administrative centre of the Zande Scheme. The district has a population of some 180,000* mostly concentrated in the wetter, richer area near the watershed. The rainfall of this region averages nearly 60 inches per annum. This falls during nine months, and there is a marked dry season. The soils are lateritic and are not intrinsically fertile, though fertility accumulates in uncultivated soils. The vegetation is grass woodland intersected by gallery forests along the watercourses. The natural conditions are, in fact, typical of this climatic zone. There are no known workable mineral resources in or near Zandeland; cattle are excluded by tsetse, and the area has to depend on its plant products for its subsistence and its wealth. The region is capable of adequate agricultural production under a conservative system of farming. Shifting cultivation is the rule, and, in a modified and organized form is considered suitable, for the present at least.

The southern provinces of the Sudan were originally taken over in a more primitive and less settled condition than the northern ones, and the consolidation of their administration and communications came too late for their extensive participation in the agricultural expansion of the nineteen-twenties, when the growing of American Upland cotton was established in other Sudan rainlands. Development was further precluded by the depression of the nineteen-thirties and the war of the early nineteen-forties. During this time the in-

* *Sudan Almanac*, 1948.

creasing sophistication of the Sudan as a whole made the development of these provinces a matter of urgency. With agricultural development in view an ecological survey was made, and a certain amount of crop introduction and experimentation was done in Zandeland and other parts of the southern provinces before and during the war, and these provided a sound technical basis for the proposals that followed. The great obstacle to developing cash crops in the Southern Sudan is its remoteness, which precludes export of all except the most valuable agricultural products. This fundamental problem is common to other central African territories, and it played an important part in the conception of the Zande Scheme.

The Proposed Scheme

The Scheme was formulated in December, 1943, by Dr. J. D. Tothill in an official memorandum (unpublished) entitled "A Suggested Experiment for the Social Emergence of Indigenous Races in Remote Areas." Tothill stressed the inadequacy of the "coastal belt" policy for regions such as Zandeland, and postulated the need for a Central African "remote areas" policy. Quoting from his memorandum: "The policy recommended is to make these areas very nearly self-contained, and to enable them to market sufficient manufactured products in the 1,000 mile coastal belt to enable them to obtain the comparatively small amount of sterling funds for self-sufficiency." Accordingly the basis of the scheme was a self-sufficiency plan whereby the primary products of Zandeland would be processed on the spot, and made available as manufactured products, thus eliminating heavy export and import costs. A proportion of the manufactured goods would be available for sale in other parts of the Sudan, thus earning enough external credit to pay for the organization, and allow for limited imports and expansion of public services. Economic development on these lines was only the means to an end, and the scheme "aims at nothing less than the complete social emergence and economic stability of the Zande people."* Tothill envisaged a thirty year period during which a civilized and prosperous, if not wealthy, peasantry would be established. He laid great stress on universal and progressive education of the right kind as a prime essential for the full consummation of his "remote area" policy.

Zandeland was chosen for the experiment because of its remoteness, because the climate and soil were good enough to make crop production reliable, because the population of the area was comparatively large and concentrated, and because the Azande were sufficiently industrious and amenable to organization. When success would become apparent in Zandeland the same principles could be applied in other remote areas.

* Tothill, J. D., *Agriculture in the Sudan*, p. 916.

The key project suggested was a cotton industry providing for growing, spinning and weaving within the district, and for export from the district of part of the cloth manufactured. The choice of cotton as the first main cash crop was a safe one. Cotton had been grown commercially for many years in similar neighbouring areas in the Congo and the Sudan (at Meridi), and small trials had been done throughout Zandeland for a number of years. These all proved that American Upland cottons were successful and well suited to the local system of agriculture. Tothill set as the final target the production and processing of 10,000 bales of lint per year, producing 1,785 tons of cloth of which 1,500 would be sold outside the district. He estimated that this would earn over £100,000 outside credit after satisfying local cloth requirements and provide a profit of £10,000 on the running of the mills.

Besides cotton the local production of the following were recommended: oil and soap from cotton seed and oil palm, gunny bags from Deccan hemp or jute; coffee, jaggery and possibly other food products; and timber products. These would also be available for trade with nearby districts producing complementary products such as meat and hides, and soap, gunny bags, and coffee were suggested for export from the district in the same way as cotton piece goods. As in the case of cotton there was already evidence that the plants producing these products grew in Zandeland, and it was feasible to recommend the starting of small pilot projects. When experience of these products had been gained some of them at a later date might partly replace cotton as the backbone of the scheme. Tothill confined definite proposals to the above products, but recommended enquiry into the use of other local resources: locally produced building materials; charcoal and producer gas made from it as fuel; and even the resuscitation in improved form of the iron smelting at one time practised by the natives.

Development of local products would be accompanied by artificial restriction of corresponding imports, which would be necessary to husband the limited amount of outside credit created.

The scheme would be established with Sudan Government capital and on a partnership basis to rule out the possibility of exploitation. At first the Azande would participate only as producers of the raw material. It was proposed that definite areas of Zandeland should be earmarked for individual project crops and that these, together with the usual food crops, should be grown by the existing family units in their own cultivations. Later the Azande would play an ever-increasing part in the management of the scheme. To manage the commercial and industrial undertakings and to supervise agricultural production a board would be formed under charter from the Governor-General of the Sudan.

Tothill recommended implementation " gradually and in orderly

steps "*—nothing else was possible because of the primitive condition of the region, but he insisted that "the first step should be bold enough to enable the board to function actively, to establish the pilot units of the basic industries and carry them through the inevitable teething troubles, and seriously to plan in detail the expansion of the whole experiment."†

Tothill's proposals were approved in principle by the Sudan Government in 1944; early in 1945 details for their implementation were worked out, and later the same year preliminary financial approvals were made and work started. The board was finally constituted and funds voted in 1946.

The Implementation of the Scheme

It is not necessary to go into details of the organization set up, or the plans made to launch the scheme, but mention must be made of the modifications and alterations which arose from the deliberations of the experts and others who studied the proposals.

The Board formed included representatives of the Sudan Government Departments of Agriculture, Economics and Trade and Administration. It was designated the "Equatoria Projects Board" and was entrusted with the management of production and trading projects in Zandeland and possibly, later, in other parts of the Equatoria Province of the Sudan.

The inclusion of a trading section in the Board was a new idea. Briefly the functions of this section are to market the products of the scheme, and to undertake wholesale and retail trade in other locally produced and imported articles. It was instituted with the following objectives: to develop a true sense of money values in a community which was not used to a money economy and which was liable to exploitation by private traders; to provide useful trade goods of good quality and at the lowest possible prices; and to train southern Sudanese (including Zande) traders. In common with other central Africans the southern Sudanese have no trading traditions and the last objective was considered most essential. The aims of the trading section, in fact, conform closely with the object of the whole scheme. This section of the Board will not achieve full status till the products of the scheme's industries are available, but it has already opened a central depot and a few shops and mobile canteens. These do good business and are much appreciated by the natives.

The idea of sealing off Zande trade by prohibition of imports was considered impracticable and dropped. This was a fundamental departure from Tothill's policy as it meant that locally produced goods must compete with imports unassisted.

* Verbatim from the Tothill memorandum. † *Op. cit.*, p. 2.

It was decided to drop the gunny bag project for the time being at least, because it was felt that there were too many imponderables to be taken into account. Experiments with jute (*Corchorus olitorius*) had shown some success, and Deccan hemp (*Hibiscus cannabinus*) grew satisfactorily as a native crop, and it was decided that experiments on growing and retting these crops should continue.

On the advice of the Economics and Trade Department it was decided that the production of coffee should not be a major project. Robusta coffee had been growing satisfactorily in Yambio for several years, and trees had been distributed amongst a few natives. It was agreed that this distribution should go on, to provide for local consumption. It was thought that Zande coffee could not compete with Congo and other imported coffee in markets outside the Southern Sudan.

Tobacco was suggested as an additional project crop. It was already grown to some extent by the natives. Experiments further proved it to grow satisfactorily. These are continuing and a decision has not yet been taken.

Groundnuts and sesame are grown as food crops throughout Zandeland, and it was agreed that the oil mills installed should be capable of pressing these seeds, thus opening a market for surplus production. Tung (*Aleurites montana*) was another oil crop which grew successfully in the Congo conditions similar to those of Zandeland. Trials still in their early stages at Kagulu (200 miles away) and Yambio itself showed promise. It was agreed to continue the Sudan experiments and keep contact with the Congo work, with a view to establishing a small tung industry. Tung oil is a sufficiently valuable product to stand export.

The cotton project, as suggested by Tothill, was accepted as the economic backbone of the scheme. Expansion of cotton growing started at once and building of an industrial town has started at Nzara fifteen miles west of Yambio. Nzara is now the headquarters of the Board. It was also decided to proceed at once with soap, palm oil and jaggery sugar projects. Of the non-agricultural projects the production of timber and other building materials was started at once, but less assured items such as charcoal and charcoal gas were postponed pending further enquiry and experiment. The Board estimated its capital expenditure at £325,000, but, with prices constantly rising during the two and a half years since the estimate was made, it is likely to reach £800,000 by the time installations are complete. This is the "bold start" postulated by Tothill.

The Sudan Government endorsed the view that cultural development must keep pace with economic development and, as Tothill intended, accepted the scheme as a social one. In addition therefore to providing funds for the Equatoria Projects Board for the industrial and commer-

cial side of the scheme, it has made substantial contributions by the expansion of public services. Improvement of communications was incidental to the industrial development, and installations and works to meet immediate and major requirements have been nearly completed. These include a trunk road from Yambio and Nzara to the river port on the Nile, and a wireless station at Yambio.

With the advancement of native welfare and culture in view the Medical Department and Education Department are increasing their services. The latter has started a very large programme aiming to establish not only literacy, but a complete cultural background to suit the people and their circumstances. At Yambio an agricultural and forestry school and an agricultural experiment station have been established. Both cater for the whole of Equatoria Province, but Zandeland will continue to be their main concern for some time. The agricultural school trains technical assistants and will provide courses for teachers and others who will have a part in forming the Zande culture of the future, and who must appreciate the great importance of agriculture in this culture.

Agricultural Considerations

The introduction of cash crops into a regime geared only to subsistence food production is bound to raise problems. Many of these were foreseen and practical solutions were undertaken at once, or their study started.

At the time of the inception of the scheme the Zande population, though socially organized in chiefships, dwelt scattered throughout the country, and practised shifting cultivation in individual family plots. It was agreed that cash crops should be included in the family cultivations, but it was realized that supervision would be impossible without some form of organization. Major J. W. G. Wyld, who had been District Commissioner in Zandeland for many years, proposed a resettlement plan which would not only facilitate agricultural supervision, but administration and the operation of educational and public health services. His plan was adopted and put into effect with such vigour that at the present time (end of 1948) approximately 70 per cent. of the entire population of the district has been resettled. The plan is to divide each chiefship into units known as *Gbarias*, each under a headman, who, according to tribal custom, is answerable to the chief or subchief. The policy is to maintain tribal structure, and to use as much as possible the authority vested in the tribal leaders, who command great respect and complete allegiance from their subjects. The *gbarias* can best be described as dispersed villages. Each contains fifty families and covers an area of two to three square miles. Each family

is allotted an area of thirty to forty acres for cultivation on a long term grass rotation system (modified shifting cultivation). The *gbarias* are laid out along straight lines which are kept open as cycle tracks, and along which each householder is required to build his house to allow of easy access. In laying out these *gbarias* due regard has been given to domestic water supplies and available agricultural land.

While the Zande Scheme was still under consideration the low intrinsic fertility of the soils and their susceptibility to erosion were strongly emphasized. Strip cropping and the use of long-term grass or bush fallows have been adopted as the basic means of dealing with these problems. A large number of demonstrators have been trained in the fundamentals of strip cropping and land measurement, and have been posted to resettled *gbarias*. The thirty or forty acre *gbaria* holdings allow for rest periods up to ten years. General conservation of water, soil, and vegetation has been catered for by reserving and protecting watersheds, streams fringes, and certain forest areas throughout the district. It is interesting to note that the Belgian authorities in the northern part of the Congo have quite independently adopted almost the same form of organization as the Zande settlements. They have instituted peasantship schemes in which the main differences are those imposed by the different vegetation—tropical rainforest as against grass woodland.

It was appreciated that grass and bush fallows were capable of wide variation in length and composition. Moreover they might not adequately maintain fertility *in perpetuo*, or be possible at all if the population increased. For these reasons maintenance of soil fertility has been made the major problem for investigation at the new experiment station. The station also has to solve various *ad hoc* problems such as variety trials, sowing dates, spacings, etc. Trials of new crops, some of which have been mentioned above, will form an important part of the work. The growing of tree crops rather than annual crops is considered to be the best form of land use for Zanda soil and climate; on the other hand, recent developments in anti-trypanosome drugs may make the introduction of cattle inevitable. Agricultural research has therefore a very wide range of possibilities with which to deal.

Zandeland is never likely to be wealthy enough to become an importer of its staple food, even for its non-agricultural population. The cultivator therefore has not only to maintain but to increase his food production while growing a cash crop. This has been accepted as policy, and it is quite within the capabilities of the Azande. Increase in food production is bound to lag behind demand, and to meet this lag the Projects Board has undertaken the production of staple foods by direct supervision. A nutrition survey has recently been completed in Zandeland and this indicates what the deficiencies in both country and urban

diets are. The adjustment of these will have an important bearing on agricultural trade developments.

Some adjustment of food habits and daily routine is likely to result from the inclusion of cash crops in native cultivations. The nutrition survey and a survey of native farming routine aim at finding out what these changes are. The day to day chores of a primitive community are not always fully appreciated, and these surveys serve a most useful purpose in preventing any major disturbance of the wellbeing or social organization of the natives.

The Cotton Project

It was decided to make a start with the smallest spinning and weaving unit that could be run efficiently, and to add to it later. Tothill had suggested an ultimate target of 10,000 bales of lint per year, but agreed that the first installation should have a capacity for a minimum of 3,000 bales, producing 500 tons of cloth. This required a production of 35,000 small kantars* of seed cotton, and the target, which it was hoped to reach in five years, was set at 50,000. For many years cotton had been grown for export and ginned at Meridi, 90 miles from Yambio. It was decided to step up production there and include it in the 50,000 small kantars required for the mill. It was estimated that Meridi could contribute 15,000 small kantars.

A ginnery has been erected and is already functioning at Nzara, but delivery of spinning and weaving machinery is not expected before 1949 or 1950. This delay has not held up the agricultural side of the project, as the present high price of lint has made export profitable even from remote Zandeland.

Tothill proposed that a high-yielding American middling cotton should be grown instead of the better quality but lower yielding American long staple strains grown elsewhere in the Sudan rainlands. This suggestion was abandoned because it was thought that the increase in yield might be less than expected, and because it was desirable to grow a cotton which could be marketed as lint with other Sudan grown cottons. The variety chosen was BAR. SP. 84. This variety was grown in other Sudan rainlands. It had been included in variety trials at Meridi for a number of years and had given consistently superior yields of seed cotton and lint, and a high G.O.T. The quality was also satisfactory. SP. 84 was originally selected at Serere (Uganda) from the Barberton strain U/4/4/2, and Knight made it homozygous for the B_2 factor for blackarm resistance (BAR).

The Board started cotton growing in 1945. In that year 80 acres was sown by selected cultivators and agricultural demonstrators under training, as a nucleus for seed supply. This area was closely super-

* A small kantar is nearly 100 lb.

vised, but 1946 saw the start of true native cotton production. It was introduced into the chiefships which had been resettled, each householder being requested to grow an average of half an acre. Further expansion took place in 1947, and it is recorded that in that season 5,400 acres were sown by 12,255 householders in 11,323 individual plots. These figures are a striking witness of the remarkable progress of both resettlement and cotton growing. This crop produced 29,000 small kantars of seed cotton and a further 11,000 were produced in the Meridi area. Thus in three years the target was already in sight. The 1948 season is not yet complete. The area is estimated at 6,400 acres in Zandeland and 3,300 acres around Meridi, and the production from this is modestly forecast at 42,000 small kantars.

Yields per acre have been maintained despite the rapid expansion. 1947 was not a good season but the yields worked out at 514 lb. per acre. This compares with 483 lb. per acre in 1945 and 514 lb. per acre in 1946. The mean Meridi yield for 1945-47 was 340 lb. per acre and the mean yield of the experimental plots throughout Zandeland before the war was 387 lb. per acre. The Zande yields compare favourably with those of Uganda,* and appear to be very similar to some Congo yields.† They are larger than was generally expected, and are attributed partly to the enthusiasm and consequent energy with which the Azande and their administrators have welcomed their scheme, and partly to the comparative absence of pests.

Seed cotton in the Southern Sudan is classified into three grades on a basis of cleanliness and apparent quality. Up to date over 60 per cent. of the Zande cotton has been top grade. This compares favourably with Meridi and is due to the same causes as the high yield. Prices paid to the natives in 1947 were approximately equivalent to 15s. 6d. per 100 lb. for grade I, 12s. 3d. for grade II, and 8s. for grade III. Slightly higher prices are being paid in 1948, but care is being taken not to risk future loss of native goodwill by paying prices which cannot be maintained.

No pest or disease has so far caused serious damage to Zande cotton. *Helopeltis bergrothii* was recorded as the most serious pest in 1946, and jassid (*Empoasca facialis*) in 1947 and 1948. BAR. SP. 84 is sufficiently hairy to be partially resistant to this pest. Egyptian bollworm (*Earias insulana*) and Pink bollworm (*Platyedra gossypiella*) have both been recorded, but not as serious pests. The Sudan bollworm (*Diparopsis castanea*) and the American bollworm (*Heliothis armigera*), which do so much damage elsewhere in Africa, are either absent or insignificant. The cotton leaf roller (*Sylepta derogata*), which sometimes causes severe local damage elsewhere in Equatoria Province, has not been reported in

* Tothill, J. D., *Agriculture in Uganda*, p. 190.
† Knaff, E. E. A., *Bulletin Agricole du Congo Belge*, xxxvii, No. 4, 1946.

Zandeland. *Lygus* spp. and stainers (*Dysdercus* spp.), which are potentially serious, have so far been light. Acariose due to a mite (*Tarsonemus lapus*) was recorded in Zandeland for the first time in 1946 by Pearson.* This is associated with forest rather than grass woodland conditions and is not likely to be as serious in Zandeland as in the Congo cotton area. Blackarm caused by *Bacterium malvacearum* is potentially a serious disease in Equatoria Province, but it has caused no damage by virtue of the resistance of BAR. SP. 84 and the newness of the cotton crop in Zandeland. *Ramularia areola* is always present in cotton in Equatoria Province, but never does much damage. Strict plant hygiene has been adopted in Zandeland as elsewhere in the Sudan. Cotton is never grown twice in succession on the same plot, and the pulling up and burning of cotton stalks is compulsory. The rich and varied vegetation makes a campaign against alternate hosts impossible.

Other problems have inevitably cropped up. The most serious to date has been poor germination of seed. This was first encountered in 1946 when tests showed about 45 per cent. germination capacity. A full stand was obtained by heavy resowing, and in 1947 and 1948 much better germination was recorded. Deterioration of cotton seed occurs in many cotton-growing countries and has received attention in America and elsewhere. The bad germination in Equatoria is thought to be due to excessive moisture or fungal attack causing fermentation in the seed, and the problem is being investigated thoroughly by field and research staff. A similar problem has been the subject of investigations in the Congo.†

The question of the best sowing period has required some consideration. Seasons are so variable that no single sowing period can be taken as the "right" one. Late sown cotton (July and August) risks having its growth arrested by dry spells which are liable to occur in September and October, and both sowing and picking clash with other native activities. On the other hand, early sown cotton is liable to suffer more severely from attacks of *Helopeltis*, and picking is done in moister conditions which may affect lint quality and seed germination. For these reasons very early sowing (April or May) is not considered advisable, and early sowing (June) has been accepted as standard practice. From the point of view of yield, both experience and trials support the June period.

A number of other agronomic problems have been under investigation both at Yambio and Meridi. Amongst other things it has been shown that the spacing adopted (90 cm. × 30 cm.) is satisfactory, and that little loss in cotton yield results from interplanting with ground nuts

* Pearson, E. O., Report on Cotton Pests in Western Equatoria Province, Anglo-Egyptian Sudan, 1946, E.C.G.C. unpublished.

† De Saeger, H., *Bulletin Agricole du Congo Belge*, xxxvii, No. 3, 1946.

or other low growing crop. This practice is allowed in native cotton plots.

The installation of an oil mill and soap factory is in the first instance subsidiary to the cotton project as only cotton seed will be available for crushing in the beginning. The necessary machinery is due to be erected at Nzara in 1949. Bad germination of cotton seed may be associated with deterioration of the oil, and in the interests of the oil and soap projects this is also being investigated.

The Oil Palm Project

As with cotton it was intended that oil palms and sugar cane should be grown as native crops, but, until both the Board and the native cultivators had more experience of these crops, the Board decided to establish and work small plantations by direct labour. These could be parcelled out later to individuals on some tenancy or co-operative basis. It was agreed that cotton growing should be allowed in areas earmarked for oil palms and sugar cane in order to provide the re-settled families of these areas with quick cash returns.

The oil palm (*Elœis guineensis*) is probably indigenous in parts of the Southern Sudan,* but its introduction as a cultivated crop is due to the Belgians between 1900 and 1910, during their occupation of the Lado Enclave. A few palms have been growing satisfactorily at Yambio and elsewhere in Zande district for some years. Conditions for oil palms are favourable only in the southerly and westerly part of Zandeland near the watershed, and the project is to be limited to these areas. 1,000 acres of oil palms had been given as a tentative target, and the Board agreed to establish on its own account a maximum of 500 acres. It is intended that this should be done in 30 acre plantations, planting out of which is due to start in 1949. A full installation for oil extraction will not be necessary till these plantations are in production, but a Miller hand press and accessory equipment has been installed to deal with the production of the present trees.

The main preoccupation of the Board at this stage is to ensure that it obtains the right oil palm variety and produces adequate numbers of seedlings. It was agreed that the project required a variety with a high proportion of pericarp, as extraction of kernel oil was not intended. As a preliminary to embarking on this project a Board official went to Nigeria to study the palm oil industry there. Besides obtaining much useful information† he was able to place an order for a supply of pedigree seed of varieties recommended for Zandeland. An oil palm seed germinator was constructed at Yambio on Nigerian lines, and has proved successful.

* Engler, " Die Pflanzenwelt Afrikas "; and others.
† McCall, A. G., " Report on a Visit to Nigeria " (unpublished).

Recording of individual yields of all the oil palms in Yambio started in 1945 and records to date show that there is a wide variation in yield and type between trees. Two known varieties, Lisombe and Deli, had been introduced at Kagulu* in 1937 and were in production by 1946. Lisombe is a thin shelled variety from the Cameroons, and Deli, which is the main variety in the East Indies, has thick shells but small seed. Seed of these and seed of the better Yambio palms were germinated pending arrival of the Nigerian seed. 7,000 seeds arrived from Nigeria in 1948 and have already germinated successfully in the germinator. These will be used for the first Board plantations. Of the Nigerian seed 2,000 were *dura* (hard shelled) × *dura*, and 5,000 *dura* × *pisifera* (seedless type), which is a thin shelled hybrid segregating for shell thickness and seed type in the F_2. Some pedigree seed is also due to arrive from the Belgian Congo.

A start has not yet been made on the problems associated with palm cultivation. The two most fundamental problems in Zandeland are the maintenance of fertility in the plantations and the conservation of moisture during a dry season which is severe enough to affect the growth of the palm. Yellowed leaves have already been noted on some of the trees in Zandeland indicating a diseased condition, possibly a deficiency. Otherwise pests and fungal diseases do not appear to be serious on the Yambio palms.

The Jaggery Project

Sugar cane of unidentified varieties has been grown to a slight extent for chewing by natives in Zandeland for a long time, and in 1940 planting material of POJ. 27/25 (a Java seedling) was introduced from Uganda for multiplication elsewhere in Equatoria Province. POJ. 28/78 and two Coimbatore varieties CO.205 and CO. 419 were introduced for trial at the same time but were not multiplied. POJ. 27/25 was planted at Yambio in 1942 and this, together with stocks at Meridi and Juba, was the nucleus of the planting material for the jaggery project. The choice of POJ. 27/25 was in the first place a matter of convenience, but its success on a commercial scale in Uganda and its resistance to virus disease also commended it. Small stocks of the varieties mentioned above are available for trial and it is likely that something better than POJ. 27/25 can be found.

Like oil palm, sugar had to be grown in the wetter areas, and a site was chosen for the project about 25 miles south of Yambio in the Nduku valley. 1,000 acres of cane per annum was given as the final target and the Board planned to establish 350 acres by direct labour. Planting started at Nduku in 1945 and by 1948 an area of over 80 acres had been planted. The factory, consisting of crushing mill and

* *Loc. cit.*, p. 7.

evaporating pans, was installed in 1948, and consequently extension of the cane area can now be more rapid. Before the power crusher was installed a limited amount of crushing was done by two small bull-driven crushers. Mean yield of cane recorded has been nearly twenty tons per acre, and up till 1948 twelve tons of jaggery had been produced experimentally. The trading section of the Board took over the disposal of this and it finds a local market at approximately 5d. per lb. Reliable juice and sugar yields per acre will not be available till the factory is working.

A certain amount of experimental work has been started in the sugar area, including spacing and method of planting trials. Growth of sugar has been very satisfactory and no pest or disease has caused serious damage.

Progress of the Scheme

Those who have been concerned with the day-to-day running of the scheme have had many teething troubles to dishearten them, and the Board has had to face constantly rising costs. Both of these are inherent in every new scheme, and, viewed objectively, the progress of the scheme has been very substantial—remarkably so when the primitiveness of the background is considered.

This review has dealt mainly with the agricultural aspects of the scheme, and it is as well to remind the reader that it is neither a cotton scheme nor an agricultural scheme. Still less is it an industrial scheme—Wyld* estimates that less than 2 per cent. of the working male population will be required for industrial work. It is in fact what Tothill originally planned, a large-scale "experiment in social emergence." The most spectacular progress is inevitably that which can be gauged by material evidence, and for the time being economic developments are more in evidence than social ones. Nevertheless the sophistication of the Azande has started (if only by their contacts with the outside world), and administrative, educational, research and welfare machinery has been brought into existence to ensure that this sophistication leads to a higher culture and an increased well-being.

Acknowledgments

The author wishes to acknowledge reference to the reports and memoranda already cited and to the official reports and minutes of the Equatoria Projects Board, all of which have been freely consulted. Figures quoted are generally from official reports.

* Wyld, J. W. G., "Aide memoire to the Zande Scheme" (unpublished).

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THE COTTON CROP OF PAKISTAN

BY

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Introduction

On August 15, 1947, was born the new State of Pakistan. The Indo-Pakistan sub-continent, which was governed and developed as a single country for the past century and a half, was on this date divided into two independent Sovereign States, the Indian Union and Pakistan. The repercussions of this division in the economic field have been enormous, and the two new Dominions have not yet settled down to peaceful life.

Pakistan is rich in agricultural resources, but is very backward in industries. There are only 15 cotton textile mills, against 300 odd in the Indian Union, no jute mills against 108, 10 sugar mills against 156, and only 2 glass factories against 77 in the Indian Union. Due to the present world shortage of machinery and difficulties of exchange, especially in the hard currency area, it will be some time before this country is industrialized. The raw materials produced here will have, therefore, to be exported for some years to come. Cotton is the most important crop of the country, and it is proposed to deal with this crop in some detail.

Pakistan has two zones, the Eastern and the Western, and practically the whole cotton crop is grown in the Western Zone.

THE COTTON CROP OF PAKISTAN

General Features

Up to now most of the cotton crop produced in Pakistan has been consumed in the Indian mills, and the outside world did not know much about this crop. This crop, however, made its first debut in the international market during 1947-48, and about 1·156 million bales were exported to different countries.

It may be mentioned at the very outset that the bulk of the Pakistan cotton crop falls within the staple-length $\frac{7}{8}$ inch to 1 inch, and is, therefore, in the class of the world's most usable staple. As the size of the crop is considerable, being about 6 per cent. of the world's total cotton crop, fuller information about it will be helpful in appreciating its importance.

Varieties

The most important varieties and their fibre characteristics are described in some detail below:

West Punjab

1. *West Punjab Desi.*—This belongs to *G. arboreum,* race *bengalense,* and is grown in scattered areas over the whole of the West Punjab. The area under this cotton at present is in the neighbourhood of 250,000 acres, and the production roughly 150,000 bales. The most important constituent is 39 Mollisoni. The staple length is $\frac{5}{8}$ inch. Its blow-room loss is 7-9 per cent., and it is capable of spinning 8's/10's reeling.

2. *West Punjab 4F.*—Acclimatized American cotton with staple $\frac{7}{8}$ inch. It is soft and silky, and the bulk of the cotton can be graded as American "Middling." Its blow-room loss is 8-10 per cent., and it is capable of spinning 20's.

3. *West Punjab L.S.S.*—A selection from 4F. Its staple is $\frac{15}{16}$ inch, and has a soft silky feel and bright white colour. Its blow-room loss is 6-9 per cent., and it can be spun into 30's warp. It is grown in Lyallpur, Sheikhupura and Sargodha.

4. *West Punjab Victory* (124*F*).—Grown in Multan, Muzaffargarh and Dera Ghazi Khan. This cotton now forms almost one-quarter of the total American crop of the province. Its staple is full 1 inch. The blow-room loss is about 8 per cent., and it can be spun to 35's warp.

5. *West Punjab Sultani* (199*F*).—The best of all American cottons grown in the Indo-Pakistan sub-continent. Its staple is $1\frac{1}{16}$ inches, and it can spin up to 40's warp.

Bahawalpur

This State mainly grows 39 Mollisoni, 4F and Victory.

Sind

1. *Sind Desi.*—Mostly grown in North Sind. The cotton is extremely white (snow white), and with a peculiar harsh and wiry feel. It mixes very well with wool. The staple is $\frac{3}{8}$ inch to $\frac{5}{8}$ inch. The blow-room loss is 6-9 per cent., and it can spin 6's/8's reeling.

2. *Sind 4F.*—A selection from West Punjab 4F, and an improvement over it. Its staple is $\frac{7}{8}$ inch to $\frac{15}{16}$ inch, and it can spin 26's warp.

3. *Sind N.T.*—A new type, the seed of which was obtained from West Punjab. The staple is $\frac{7}{8}$ inch to 1 inch. It can spin 28's warp.

4. *Sind M.4.*—The most popular variety now grown in Sind. Its staple is $\frac{15}{16}$ inch, and can spin 38's warp.

Area

The area under cotton during the last few years in the different provinces of Western Pakistan along with that of the Indian Union is given in Table I.

TABLE I.—ACREAGE UNDER COTTON IN DIFFERENT PROVINCES
(000's Omitted)

Year.	*West Punjab.*	*Sind, including States.*	*Bahawalpur.*	*N.W.F.P.*	*Total Pakistan.*	*Indian Union.*
1937–38 ..	3,119	1,049	460	22	4,650	21,009
1938–39 ..	2,176	902	395	22	3,495	19,899
1939–40 ..	2,037	903	311	17	3,268	18,218
1940–41 ..	2,092	999	372	13	3,476	19,727
1941–42 ..	2,165	999	429	15	3,608	20,435
1942–43 ..	1,868	729	396	16	3,009	16,087
1943–44 ..	2,037	951	476	16	3,480	17,522
1944–45 ..	2,090	896	408	16	3,410	11,322
1945–46 ..	1,958	826	405	15	3,204	11,290
1946–47 ..	1,900	830	384	9	3,123	—

It will be seen from Table I that the fluctuations in the annual area under cotton in Pakistan have not been very wide. The year 1937-38 was the peak year for area, and this limit has never been touched again. It may also be mentioned that during the World War II the necessity for producing food was over-riding, and the area under cotton registered a steep fall in the Indo-Pakistan sub-continent. This reduction mainly took place in parts now included in the Indian Union. The fertile plains of the Indus valley continued to produce cotton at practically the pre-war level.

Pakistan is at present one of those fortunate countries where food appears to be ample, and, therefore, the area under non-food crops need not be restricted in favour of food crops. The area under cotton will thus show an upward tendency in the near future. The new irrigation projects nearing completion (Thal in West Punjab), or under contemplation (Lower Barrage in Sind), will add to the present area under cotton.

Yield per Acre

The yield per acre in Pakistan is already the highest amongst all the different parts of the Indo-Pakistan sub-continent. It has already been shown elsewhere (Afzal, 1947) that an average yield as high as 237 lb. of lint per acre has been obtained in certain years in the West Punjab.

The yield of all crops in the Indian Union is proverbially low and very variable. This is mainly due to the lack of irrigation facilities. With a hot climate the availability of soil moisture becomes the limiting

factor in crop husbandry, and irrigation facilities thus assume an overriding importance. Nature has been bountiful to Western Pakistan, and the water resources are dispersed in such a way as to make irrigation both easy and cheap. It is for this reason that Western Pakistan possesses the greatest canal system in the world.

Rivers have always been the life-creators, life-givers and life-sustainers. Great civilizations have had their birth in river valleys. The remains of two prehistoric civilizations can even now be seen in Taxila in West Punjab and Mohenjo-Daro in Sind. Great centres of commerce, industry, art and culture have flourished on river banks, and rivers have been the main arteries of the economic body of the countries through which they flow. The four rivers of Western Pakistan have come to occupy an important place in the agricultural economy of the country. The triumph of man over nature is nowhere better typified than in Western Pakistan, where human ingenuity and skill have harnessed all the rivers for the service of man. The great canal system has turned vast tracts of inhospitable land into rich agricultural districts. These areas now support extensive agriculture sustaining millions of people. Surely and steadily these mighty rivers are now creating a new civilization on their banks. King Cotton has participated in this march of progress, and is today a vital factor in the economy of Pakistan.

A comparison of the area under irrigation in the Indian Union and Pakistan will be of interest. These figures are given below:

Total area under cotton in the Indo-Pakistan sub-continent during 1937-38	25,668,000 acres.	
Area under cotton in the Indian Union during 1937–38	21,009,000 acres.	
Cotton grown under irrigation in the Indian Union during 1937–38	906,000 acres.	
Area under cotton in the territories now in Pakistan in 1937–38	4,659,000 acres.	
Irrigated cotton area in Pakistan during 1937–38	3,650,000 acres.	
Percentage of irrigated area to total cotton area in	Pakistan ..	78·9 per cent.
	Indian Union ..	4·9 per cent.

It is mainly due to irrigation facilities that the yield per acre is very high in Pakistan, as compared to that of the Indian Union. The evolution of high-yielding varieties and better soil and crop management have contributed their share, and it has been estimated (Afzal, 1947) that the average yield per acre in the West Punjab has increased by about 16 per cent. during the last twenty years. The yield in the Indian Union has been practically stationary, and now stands at about 70 lb. of lint per acre.

Production

The total cotton crop of the Western Pakistan and the Indian Union during the past few years is shown in Table II.

TABLE II.—COTTON PRODUCTION IN BALES OF 400 LB. EACH (000'S OMITTED)

Year.	*West Punjab.*	*Sind, including States.*	*Bahawalpur.*	*N.W.F.P.*	*Total Pakistan.*	*Indian Union.*
1937–38 ..	878	487	145	7	1,517	4,017
1938–39 ..	904	425	132	12	1,473	3,690
1939–40 ..	832	399	146	3	1,380	3,574
1940–41 ..	969	467	192	3	1,631	4,427
1941–42 ..	1,068	446	197	3	1,714	4,343
1942–43 ..	998	456	189	3	1,646	2,586
1943–44 ..	807	548	172	3	1,530	3,450
1944–45 ..	795	445	156	3	1,399	2,406
1945–46 ..	809	375	166	3	1,353	2,227

It is clear from the figures given in Table II that the production in Pakistan is very considerable, and, on the average, 1·5 million bales of 392 lb. net may be expected every year. With the completion of the new irrigation projects the production will be increased still further.

As very little cotton is consumed in the country, all the produce is available for export.

A comparison of the total production of cotton in Pakistan with that of the Indian Union will not be amiss at this stage. It will be seen from Table I and Table II that, during recent years, with practically one-fifth of the area, Pakistan produced about two-fifths of the crop produced in the Indo-Pakistan sub-continent. The Indian Union is hopelessly short of food, and the statutory restriction of area under the non-food crops will have to continue there. Thus the Indian Union will not be able to show any appreciable accession in the cotton crop within a measurable future. It will be remembered that during World War II, the Government of India reduced the area under cotton in some of the provinces under the Defence of India Rules. The sheer necessity of producing food in the Indian Union will continue to exist for some time.

Quality

Western Pakistan comprises West Punjab, N.W.F.P., Sind, Baluchistan and States. These will be dealt with separately. So far as cotton is concerned, West Punjab, Sind and Bahawalpur are important tracts.

There are two types of cotton grown in the West Punjab, the short-staple Asiatic cotton (*G. arboreum*, race *bengalense* Hutchinson), and the American cotton (*G. hirsutum*). The staple of the Asiatic cottons is only about ⅝ inch, and is very rough and woolly. Amongst the American there are several varieties capable of spinning 20's to 40's. A distinct change-over in the area from low counts to high counts has been noticeable during the last twenty years. Figures given in Table III are interesting in the connection (Afzal and Nawaz, 1947).

TABLE III.—ACREAGE (ESTIMATED) UNDER DIFFERENT VARIETIES OF COTTON
(000's OMITTED)

Year.	*Asiatic Varieties.*	*American* (20's).	*American* (30's).
1931	—	744	19
1934	846	763	78
1937	1,692	1,115	312
1940	706	896	490
1943	251	537	1,249
1946	300	315	1,285

It will be seen that low spinning cottons have steadily yielded place to high-class varieties. This tendency is still persisting, and it is hoped that, ultimately, West Punjab will not grow any cotton spinning less than 20's.

A similar state of affairs has been noticeable in Sind and other constituent States of Pakistan.

Pakistan is thus a repository of high-grade cotton in the Indo-Pakistan sub-continent. A comparison between Pakistan and the Indian Union so far as quality is concerned is very illuminating, and figures are presented in the subjoined table.

TABLE IV.—PRODUCTION IN BALES OF DIFFERENT STAPLES (OFFICIAL FORECAST 1945–46)
(000's OMITTED)

Staple Length.	*Indian Union.*	*Western Pakistan.*			
		West Punjab.	*Sind.*	*N.W.F.P.*	*Total.*
Over 1 inch	23	58	—	—	58
One inch	76	—	26	—	26
$\frac{7}{8}$ inch to $\frac{31}{32}$ inch	976	800	292	—	1,092
$\frac{11}{16}$ inch to $\frac{27}{32}$ inch	405	—	—	2	2
$\frac{9}{16}$ inch to $\frac{21}{32}$ inch	254	—	—	—	—
$\frac{17}{32}$ inch and below	357	116	53	—	169
Total	2,091	974	371	2	1,347

It will be seen that, while there is a large assemblage of varieties of all staple lengths in the Indian Union, Pakistan produces certain well-defined types with emphasis on high staple length.

A GLIMPSE OF THE FUTURE

Pakistan is determined to take its place amongst the countries producing long staple cottons, and the present work is directed towards this end. Some of the efforts in this direction have already been described elsewhere (Afzal, 1946 *a*, *b*, and 1948), and it will suffice to say here that *Jubilee* (Afzal, Sikka and Rahman, 1945) will shortly

replace the low-grade Asiatic sorts, and that American cottons capable of spinning 60's and above will be extensively grown. The Commonwealth will watch these developments with interest.

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REVIEWS

AGRICULTURE IN THE SUDAN. By Numerous Authors. Edited by J. D. Tothill, C.M.G., D.Sc., B.S.A. London (Oxford University Press, Geoffrey Cumberlege. Pp. 974. 42s. net.) Following the lines of his "Agriculture in Uganda," but with a wider range, Dr. Tothill has collected here contributions from twenty-eight authors. Their work, with an abundance of photographs, maps and tables has, by the use of India paper, been compressed into a volume which, while it is described as a handbook, is encyclopædic in scope if not in structure. In a primitive country entirely dependent on the produce of the soil there can be little that is irrelevant to agriculture and, apart from the political structure and the less material aspects of native life, all that is essential to a broad knowledge of the Sudan would appear to be included in this book.

Until fairly recent times attention has been concentrated on the development of cotton under irrigation, and this, with its complementary crops of Sorghum for human food and Dolichos for fodder, provides the mainstay of the country's economy. But Dr. Tothill reminds us that the Sudan is a country "that extends from rainless desert to tropical rain forest; from the trade-wind zone to the doldrums; from irrigation to rain agriculture; from settled areas to places where only Bedouin tribes can live; and in elevation from 408 ft. above sea-level at Wadi-Halfa to 10,000 ft. more or less on Jebel Marra and Mount Kineti."

The two southern Provinces—Upper Nile and Equatoria—bordering on Kenya, Uganda and the Belgian Congo, have together an area of over a quarter of a million square miles. Their population is estimated at one and three quarter millions made up of pagan negroid tribes, some strictly pastoral, the rest practising shifting cultivation. Here are all the problems of tropical Africa familiar in their southern neighbours, and it is well to remember these areas when the political future of the Arabic-speaking peoples further north is under discussion. A novel form of development suitable for remote areas, designed by Dr. Tothill and aiming at a large measure of self-sufficiency, is being tried in the Zande area of Equatoria.*

* See Ferguson: TheZande Scheme, p. 109 of this issue

The economic foundation having been provided, "the present agricultural policy of the Sudan may be said to be designed to bring about the social emergence of rural communities, rapidly becoming fully literate, financially able and mentally wishing to participate in the advance of civilization and taking an ever-increasing interest in the management of their own affairs." It is emphasized that the essential requirements for a happy and prosperous rural life are few and simple, and it is claimed that in some parts of the Sudan at any rate, and perhaps in many, this state has been satisfactorily achieved. One might remark that its more general attainment and its maintenance must depend, for a long time to come, on the existence of a paternal government which itself remains immune from the grosser forms of "development."

Following the Editor's Introduction, the general chapters deal respectively with history, vegetation, climate, geology and soils; then with transport, land tenure, revenue, education, and nutrition. They also include a study by Dr. Tothill of the serious problem arising from the subdivision of land under the Muslim laws of inheritance, which with an increasing population leads inevitably to impoverishment. The existence of individual ownership of land among the Arabic-speaking peoples has greatly complicated government schemes for development and resettlement, and considerable powers of temporary or permanent expropriation have been found necessary in the public interest.

The succeeding section contains chapters on crop production, irrigation, animal husbandry and related matters. Two chapters of especial interest were contributed by the late Dr. Frank Crowther, dealing with the organization of Agricultural Research and a Review of Experimental Work. The latter, which follows in considerable detail the progress of researches on soil, husbandry, cotton yields, plant breeding and introduction, and major crop pests and diseases, is in itself an outstanding textbook of agricultural research, illustrating its methods, difficulties, and successes, and not least in importance, its pitfalls for the unwary, even the eminent.

The final section provides a series of exceedingly interesting accounts of local agriculture, province by province. Here will be found a detailed description of cotton development in the Gezira and elsewhere and much original information about conditions and developments in the little-known areas of the outer Provinces.

The value and importance for study and for reference of "Agriculture in Uganda" and "Agriculture in the Sudan" prompts the wish that it were possible for Dr. Tothill to perform a similar service for the other British dependencies in turn. On second thoughts one realizes that it is only the existence of the records of long and devoted service by many men in numerous and varied types of organization which makes such a compilation possible. In both the countries concerned the problems involved in cotton growing have had an important part in stimulating research, and its profits in helping to pay for it. There is at least one area which should be ready for similar treatment, since it was the cradle of tropical agriculture and of its scientific investigation: the British West Indies.

Dictionary of Genetics—Including Terms used in Cytology, Animal Breeding and Evolution. Compiled by R. L. Knight, D.Sc., Ph.D., A.I.C.C.A. (Waltham, Mass.: The Chronica Botanica Co.; London W.C. 2, Wm. Dawson and Sons, Ltd. $4.50.) Dr. Knight is well known for his almost classical studies on the genetics of resistance to the Black Arm disease of cotton in the Sudan, and for the great success which his resistant varieties have had in the economy of Sudan cottons. It is evident that he, in common with most working geneticists and plant breeders, has felt the need for a dictionary of technical terms. At present it must be admitted that the number of technical terms in genetics has got completely out of hand, and I doubt whether any geneticist is familiar with more than a modest proportion of them.

The author, then, has faced a task of no small difficulty. On the one hand he has to satisfy the pure research worker in genetics or cytology, and on the other, the more general reader, not an expert, who gets confused with the multiplicity of terms and feels the need to come up for air now and again.

Having regard to these considerations, I think that the author has acquitted himself pretty well. If one wants to be a complete purist and pedant, one might say that the book has to fulfil two conditions, it must be complete, and it must be authoritative. To be quite fair, it occasionally, but surprisingly infrequently, falls short of fulfilling either of these conditions. To many it would seem that the historical aspect of a given term is important, and therefore the author of the term should if possible be given, so that the reader can see how it came into being and know something of its historical context. For example, the definition of Eugenics given in the book is:

> Eugenics—the application of the principles of genetics to the improvement of a race (especially of humans).

The one given by Galton, the originator of the term, and the one still adhered to by the Eugenics Society, is " the study of all the agencies under social control which may improve or impair the inborn qualities of future generations of man, either physically or mentally."

Sometimes, of course, by general consensus of opinion, the meaning of a term may be changed; often it is necessary to change it. It may be that the definition given by the author is more in keeping with modern usage than the stately and Victorian definition of Galton.

Now regarding completeness, I have tested the book thoroughly. Some missing terms which occur to one are: antigen, Linnæon (of Lotsy), mutagen, carcinogen, virus and proband. Generally missing, in fact, are the more specialized terms used in human heredity. Perhaps in the next edition these and other omissions can be rectified. Perhaps it is not easy to justify the admittance of " scopa," the posterior metatarsal pollen brush of bees, and " sarathrum," pollen brush of insects. But to sum up, 95 per cent. of the readers will find what they want 95 per cent. of the time. Thus, in spite of a few shortcomings, the book is certainly worth a place in the library of all plant breeders, geneticists, and of all general readers who try to understand where genetics is going.

S. C. H.

NOTES ON CURRENT LITERATURE

COTTON IN INDIA AND IN PAKISTAN

125. Indian Cotton before and after Partition. By M. S. Natesan. (*Ind. Cott. Grwg. Rev.*, ii, 4, 1948, p. 159.) As a result of the partition of the country, the Indian Union's share of undivided India's production of cotton of staple length $\frac{7}{8}$ in. and above, below $\frac{7}{8}$ in. and above $\frac{11}{16}$ in. and $\frac{11}{16}$ in. and below forms 45, 62 and 76 per cent. respectively, on the basis of the figures for 1946-47. The Indian Union's output of cotton of staple length 1 in. and above forms about 33 per cent. of that of undivided India. The present production of cotton of staple length " $\frac{7}{8}$ in. and above " and " below $\frac{7}{8}$ in. and above $\frac{11}{16}$ in." in the Union should be raised by at least 80 and 39 per cent. respectively, to meet internal requirements in so far as Indian and Pakistan cottons are concerned. The production of cotton of staple length $\frac{11}{16}$ in. and below at the current level is just sufficient to meet internal demand. It is possible to attain self-sufficiency, in the immediate future, in regard to the requirements of mills in the Indian Union in respect of Pakistan cotton, except perhaps for a moiety of the 2 lakhs bales of staple length 1 in. and over at present being obtained from Pakistan, provided the food position permits of an increase of about 4 million acres in the area under cotton as compared with 1946-47 when the acreage was 11·5 millions.

126. Crop Prospects. (*Cott. and Genl. Econ. Rev.*, 7/1/49.) The official estimate of the 1948-49 Indian Union crop is 2,370,000 bales, compared with 3,000,000 bales last season. The reduced forecast is based on the acreage harvested, bad weather, cyclone damage in the Central Provinces, the Berar and Central India, and an irregular monsoon in the Broach, Surti, Hyollera and Mathia districts. Present prices for Broach Vijay seed cotton work out Rs. 100 per candy above ceiling rates, and there is a rush of buying due to estimates of a Vijay/Surti crop of only 175,000 bales, as against 320,000 bales produced last year. The staple of the current crop is also definitely short compared with the previous harvest.

127. Report on the Accuracy of the All-India Cotton Forecasts of the Five Seasons ending 1945-46. (Ind. Cent. Cott. Comm., Stat. Leaflet 5, 1948.) This report which was discontinued during the war is now being resumed, and in this issue deals with the results of the post-mortem examination of the cotton forecasts of the seasons 1941-42 to 1945-46. Details are given of the two formulæ used for estimating the forecasts. A wide disparity in the figures arrived at by the two methods is apparent for the individual years, but when the figures for a five-year period are taken as a whole the error, which is largely due to the incompleteness in the figures of trade stocks, is considerably minimized.

128. New Variety of Cotton. (*Ind. Farm.*, vol. ix, 7, 1948, p. 312.) A new variety of cotton known as Mysore-American V has been evolved by crossing Co. 2 (a Cambodia pure strain), which is much superior to local Doddahatti grown in the northern and central tracts of the Mysore State since 1850. M.A.V. cotton grows well both under irrigation and rain-fed conditions. It is fairly resistant to Red Leaf Disease, unlike Doddahatti, which is very susceptible to it. The plants are characterized by broad leaves and big bolls which open well. Its staple length is $1\frac{1}{8}$ in. and its ginning outturn goes up to 35 per cent. Its cotton spins up to 36's Highest Standard Warp Counts. The yield varies with the type of cultivation from 400 to 1,350 lb. of kapas per acre.

129. Note on the Trial of Cambodia Cotton at the Agricultural Research Station, Aduturai, Tanjore Delta. By M. Anandan. (*Ind. Cott. Grwg. Rev.*,

depression, the price of rice slumped badly, experiments were undertaken in the purely rice-growing area of Tanjore to discover if Cambodia cotton could be grown as a supplementary crop without detriment to the yield of the rice. Results showed that there were two alternatives to meet the requirements of green manure by the rice crop following cotton. (i) To sow a green manure crop in the cotton crop itself for ploughing in after the cotton plants have been pulled out. (ii) To sow a green manure crop like *Sesbania speciosa* in a neighbouring field in the standing crop of rice a fortnight before its harvest. Under alternative (i), a crop of *Pillipesara* (*Phaseolus trilobus*) was sown in the interspaces between the cotton plants in June and allowed to grow. This creeping plant did not interfere much with the movement of the women engaged in picking the cotton. Alternative (ii), however, provèd to be a far better proposition: an acre of *Sesbania speciosa* grown in the midst of a 10-acre block of cotton yielded enough green matter to manure the rice crop succeeding the cotton crop in the entire 10 acres. If this practice is systematically followed, there is no fear of the rice yield decreasing, but, on the other hand, there is real scope for increasing the yield of rice much above the present average yields.

130. Studies in the Quality of Hirsutum Cottons grown under Irrigation on the Arbhavi Farm. By H. R. Nayak. (*Ind. Cott. Grwg. Rev.*, ii, 4, 1948, p. 178.) Four cottons—namely, Co. 2, Co. 3, Co. 4 and 9766—were tried at Arbhavi Farm during the four seasons—*i.e.*, 1942-43, 1943-44, 1944-45 and 1945-46—with the object of finding out the best and the most suitable cotton for the Belgaum district, especially where irrigation facilities are available. The fibre and agronomic characters such as fibre length and its distribution, fibre weight per unit length, percentage of mature fibres, maturity coefficient, mature fibre weight, ginning percentage, lint index, number of fibres per seed and yield per acre were studied, and the following conclusions drawn. The variety Co. 4 has given a significantly longer fibre length than the other three varieties. Co. 4 and Co. 3 are significantly finer than Co. 2 and 9766. Co. 2 has given a significantly lesser number of mature fibres. Co. 2 has given a significantly lower maturity coefficient. Co. 3 and Co. 4 have recorded significantly low values for mature fibre weight, while Co. 2 and 9766 have given significantly higher values. Co. 4 has been proved superior to the other varieties studied in this paper, and highly suitable for the irrigated tract of the Belgaum district.

131. Cotton Seed Oil and Cake. By M. Afzal. See Abstract No. 199.

COTTON IN THE EMPIRE

132. BURMA. (*Cott. and Genl. Econ. Rev.*, 7/1/49.) Acreage under cotton this season is estimated in the third official forecast at 216,800 acres, a decrease of 4,871 acres on the area planted last season. Acreage abandoned is given as 22,270 acres, an increase of 6,310 acres on 1947-48. The acreage likely to be harvested is therefore 194,530 acres, as against 203,240 acres last season. The total outturn of the 1948-49 crop is now estimated at 6,156 tons, compared with 7,500 tons actually harvested in 1947-48. The reduced yield this season is due to deficient rainfall during the growing period.

133. CANADA. Cotton Consumption. (*Cotton*, M/c., 12/3/49.) Consumption of cotton in Canadian mills amounted to 34,608 bales in December, 1948, compared with 34,293 bales in November, and with only 28,942 bales in December, 1947. The December figure was the highest for any month since March, 1947, while consumption over the whole of 1948 was the highest for any year since 1943. At 382,460 bales it was 19,198 bales more than that for 1947. The average monthly consumption of 31,871 bales for 1948 compares with 35,426 bales for 1943, 41,342 bales for 1942, 40,951 bales for 1941, and 37,930 bales for 1940.

134. CYPRUS. Cotton Production, 1947. (*Ann. Rep. Dept. Agric.*, 1948, p. 3.) Cotton production and export figures for 1947, 1946 and average 1935-39 are given. Cotton yield in 1947 was satisfactory, but production was less than in 1946 as the area of cotton sown was reduced.

135. AFRICA. KENYA: COTTON CROP. (*E. Afr. and Rhod.*, 30/12/48.) The cotton crop in the North Nyanza district of Kenya is expected to realize between £75,000 and £100,000 this season.

136. NIGERIA: COTTON PROSPECTS, 1948-49. (*Half-yrly Rpt.* to December, 1948.) *Northern Provinces.*—Cotton-seed distribution totalled 6,468 tons compared with 5,655½ tons the previous year, an increase of 14·4 per cent. 25 per cent. more seed was distributed in Katsina Province, accounting for 495 tons, but substantially increased supplies were absorbed throughout the main growing areas. Seed distribution is not a reliable index of the export crop, but all reports speak of an increased acreage under cotton. The season was very favourable for July planting, and, except in Southern Katsina, the weather was ideal up to the end of September. The abrupt cessation of rain and the early October onset of harmattan caused a high rate of boll shedding, and yields, especially of late-sown cotton, will be adversely affected. In addition, heavy August and September rainfall in Southern Katsina caused much water logging and damage to the crop. Although hopes of a record yield have been disappointed, it is expected that the increased acreage will offset lower yields, and that the tonnage picked will show a substantial increase over last season. The multiplication of the Botanist's Strain 26C has been speeded up, and it is expected that 400 tons of this strain will be purchased at Daudawa Multiplication Area Market this season. Seed from this area should be sufficient to replace commercial Allen seed at the Faskari dump in 1949. Twenty-three new markets were opened, bringing the total up to 86 during the current season. The opening dates were fixed at November 5 in Northern Katsina and December 3 in the main cotton belt. Purchases to the end of the year showed improvement over those of last year owing to a reduction in the requirements of the local spinning industry. The decision to pay a flat price at all gazetted markets of 4d. per lb. grade I represents a substantial increase in price over the range of from 2·4d. to 3d. per lb. according to last year's transport differential. N.A.II flat rate of 3·9d. compares with from 2·1d. to 2·5d. per lb. 1947-48.

Western Provinces.—All cotton being grown at Meko is from the previous year's crop; two bags of Botanist's cotton from Ibadan arrived too late for multiplication. 2,697 lb. of seed were distributed in the Meko area. DDT, which was used at Moor Plantation during the 1948 growing season, shows promise of being able to control the pests of cotton which have caused the failure of cotton there in recent years. It is hoped in future to be able to grow sufficient seed for multiplication at Meko. Total distribution of improved Ishan seed in Oyo Province and Abeokuta Province (excluding Meko) was 20,829 lb. and 14,639 lb. respectively. The demand for seed cotton for local spinning and weaving remains high and it is unlikely that any will be offered for grading, except in Meko. Weather conditions were not so favourable as in 1947, and a number of farmers failed to establish their crop successfully owing to the prolonged drought between the rains. *Helopeltis* damage has nowhere been as severe as on the plots at Moor Plantation untreated with DDT. Leaf curl caused by a white fly which is carried over from one crop to the next by old cotton plants is noticeable on a number of farms at Meko.

137. COTTON CROP. (*Ann. Rep. Dept. Agric.*, 1945, Received 1948.) Contains the official report on the cotton crops in the Northern and Southern Provinces, including the report of the Entomological Section on pests affecting cotton.

138. CROP PROSPECTS. (*Cott. and Genl. Econ. Rev.*, 7/1/49.) Lack of late rain, coupled with early harmattan conditions, will affect the yield of the late-planted crop. Recent reports from the main producing areas indicate the possibility of a crop of some 40,000 bales (400 lb.) of cotton lint. Actual purchases for export will, however, depend largely on the strength of competitive buying by the local spinning and weaving industry.

139. NIGERIAN COTTON COMMITTEE. (*Crown Col.*, Dec., 1948, p. 708.) The Nigerian Government had decided to set up a Cotton Marketing Representative Committee in accordance with proposals placed before the Legislative Council at its last meeting.

Unofficial Members of the Northern House of Assembly; the sixth will be nominated by the Cotton Marketing Board. Those nominated for the Committee will be African members of the cotton areas, but need not necessarily be members of the House of Assembly.

140. NYASALAND. (*Dept. Agric. Report*, Nov., 1948.) Final purchase figures for the Southern Province crop have now been received and show that a new production record has been established, namely 7,023 short tons. The total production in the Central Province was 222 short tons. In the Northern Province the estimate for the Karonga crop of 400 short tons remains unaltered. In the Southern Province increasing transport difficulties have hindered the movement of cotton seed from the ginneries to the seed depots; no issues are made until towards the end of December. In the Lakeshore areas of the Central Province seed distribution continues but interest in cotton growing appears to be lukewarm, especially where there is any possibility of tobacco production.

141. NORTHERN RHODESIA. (*Dept. of Agric. Ann. Rep.*, 1947. Received 1948.) A description is given of the measures undertaken for the reclamation and preservation of the fertility of the soil in native areas. The total production of cotton lint was about 2,000 lb., which was sold at 1s. per lb.

142. SOUTHERN RHODESIA: COTTON INDUSTRY. (*Platt's Bull.*, **6**, 1948, p. 61. From *Text. Tech. Dig.*, v, **12**, 1948, p. 728.) The cotton-spinning mills established by the Cotton Research and Industry Board of Southern Rhodesia at Gatooma are briefly described. Details of the machinery and layout of the plants are given. A cotton-breeding station has been established near the mills. It is claimed that the natural characteristics of Southern Rhodesian cotton, together with breeding research, have made this cotton the whitest in the world.

143. DEVELOPMENT PROJECT. (*E. Afr. and Rhod.*, 25/11/48, p. 351.) From the new £5,000,000 loan offered for subscription by the Government of Southern Rhodesia, the amount of £520,000 will be issued to the Cotton Research and Industry Board for expansion of its spinning mills at Gatooma and to finance the purchases of seed cotton and cotton lint for spinning.

144. SOUTH AFRICA: COTTON INDUSTRY. (*Cotton*, M/c., 20/11/48.) In a review of the cotton industry it is stated that after 1929 production decreased rapidly. The peak year was 1925-26, when the crop reached 16,300 bales of 500 lb.: in 1945-46 production was only 275 bales, but in the following year it increased to 919 bales. The increasing demand for fibre by South African industries and a rise in cotton prices have stimulated interest in this crop, and this year the preliminary estimate is a crop of 2,500 bales, but the final figures may be as high as 3,000 bales. The general quality of the crop is good. The entire production of fibre was sold locally at 16d. per lb.

During the war a spinning and weaving factory was established. It has since been considerably expanded, and two more factories have reached the production stage. Several other companies are also reported to be considering the possibility of establishing factories in the Union.

Imports of cotton fibre from 1941 to 1945 averaged some 46 million lb. In 1946 they reached 86 million lb., whilst imports in the first quarter of 1947 showed a 50 per cent. increase over those in the corresponding period in the previous year. Later import figures are not yet available, but it is believed they will reflect a further considerable advance as some of the factories are only now reaching full production.

145. SUDAN: COTTON CROP, 1947-48: AGRICULTURAL RESEARCH. (Res. Div., Dept. Agr. and For., Mem. 8.) Egyptian Cotton.—In the Gezira yields were greatly improved by spraying with DDT against jassid. It was a season of heavy attack by this pest in the northern half of the Gezira, and on some of the White Nile schemes. Almost 45,000 feddans were sprayed by Messrs. Pest Control Ltd., of Cambridge. Research on various aspects of the jassid problem was continued. The host plants during the dead season were studied and found to be confined almost, if not entirely, to the scattered gardens and riverain cultivations; spraying of certain gardens was unsuccessful in controlling the outbreak on cotton near by,

but evidence was obtained that the spread to cotton does take place from gardens. Blackarm damage was mainly light, but there were severe local outbreaks of leafcurl. Investigations showed the commercial grading of the crop to be excellent, but efforts were made to improve the grade and lessen seasonal variation. At the Gezira Research Farm trials were carried out on varieties of Domains Sakel, X.1730A and Blackarm Resistant strains. American Cotton.—Work at the Shambat Station was confined to experimental genetics. It included an attempt to introduce the blackarm gene B_3 to BAR SP.84 which is homozygous for B_2 and has been accepted for the present as the commercial variety in the Nuba Mountains and Equatoria. Attempts to produce bollworm resistant Uplands were also continued. In an interesting factorial experiment at Talodi, certain indications were obtained for light land in a season of high rainfall. For maximum yield spacing should not exceed 90×90 cm. and may possibly be closer with advantage; the seed-rate should not exceed 10 seeds per hole, provided that the seed has not been damaged, and not more than four plants per hill should be left at thinning time. In the Nuba Mountains, Egyptian, Sudan and pink bollworms caused damage of varying intensity. At Kadugli the stainer *Dysdercus superstitiosus* reached epidemic proportions, but true staining of cotton was very light. In the Equatoria Province pink bollworm was general, and jassid damage was severe at Yambio. Lygus damage was especially noticeable in areas with a high proportion of Eleusine millet.

146. TANGANYIKA: CROP PROSPECTS. (Dept. Agric. Crop Report, Dec., 1948.) Extensive planting has taken place in the Lake Province, but the growth of early planted cotton which has germinated is slow because of insufficient rain.

147. COTTON GINNING IN TANGANYIKA AND COMMENTS THEREON. By R. I. Butler. (*E. Afr. Agric. J.*, xiv, 2, 1948, p. 101.) The author describes the processes to which seed cotton is subjected at the ginneries in Tanganyika. Details of the seed cotton opener, and the standard types of gins and baling press used are given. Comment is made on the effect of temperature and humidity on the ginning outturn. The author stresses the need for cleanliness in the ginneries and draws attention to the damage that can be done to the lint by bad handling and neglect of machinery. Finally it is suggested that advantage should be taken of as much mechanization as possible at ginneries.

148. EXPERIMENT IN LOCAL GOVERNMENT IN TANGANYIKA. (*Crown Colonist*, Jan., 1949, p. 50.) The great Sukumaland experiment in African administration reached a new stage on November 25, 1948. The Acting Governor, Mr. E. R. E. Surridge, opened the central headquarters of the Sukumaland Federation—an Authority of fifty chiefs ruling 20,000 sq. miles and a million people. The chiefs will be responsible for local administration on a scale never before attempted, and for an equally unprecedented development of the land. Sukumaland is in the Lake Province of Tanganyika, and Malya, the new headquarters, is 60 miles south-east of Mwanza, the Lake port. It is open, gently undulating and rather arid country, grossly overcrowded with men and beasts, and suffers from severe soil erosion and deterioration of productivity. The Development Team (senior administrative officers, agricultural, veterinary, forestry, livestock, education and water development officers) has the Federation Team (the chiefs) as its "agents" in dealing with the people of the area. Without the unified authority of the Federation such work as land reclamation and rehabilitation, the spreading of people and livestock into areas at present unoccupied, the provision of water supplies, and the improvement of methods of cultivation, could not be done on the scale required. Co-operation on a huge scale is needed, and that is what the Sukuma chiefs and people, in Tanganyika's biggest experiment in local government, are providing.

149. UGANDA: COTTON CROP. By A. G. C. Deuber. (*British East Africa—Economic and Commercial Conditions*, H.M. Stat. Off., 1948. Price 2s.) The Cotton Association of Uganda at their last annual meeting reflected in their report the great concern that is felt at the progressive decreases of production which have taken place since 1942. In 1946 the crop reached the low figure of 227,000 bales, the estimate for the 1947 crop being still less and only in the region of 170,000 bales, which, with

the exception of the 1943 figure, is the lowest recorded since 1931; as a comparison the 1938 figure was 407,000 bales.

These reductions are due partly to the greater attention that was paid during the war to the growing of food crops, but are also largely caused, it is understood, by the fact that cotton prices have not increased at the same rate as have those for other crops, particularly coffee; the result is that the native growers are inclined to pay more attention to the cultivation of the latter as well as of soya beans and other seeds. Production is entirely in the hands of Africans, the raw cotton being treated locally in ginneries which are mostly owned by Asians.

The estimated acreage under production during the 1945-46 season was 1,145,568, the crop of seed cotton 135,525 tons, the acreage yield per acre 265 lb. and the average price Shs. 16·40 cents per 100 lb. Comparable figures for the 1939-40 season were 1,267,736 acres, 179,045 tons, 310 lb. and Shs. 11·14 cents. The latest report issued by the Uganda Department of Agriculture indicates the probability that for such time as the demand for subsidiary crops remains at its present level, cotton is unlikely to regain its pre-war position of pre-eminence; every effort is being made, however, in an endeavour to ensure that production is maintained and, by the introduction of improved agricultural practices, is further stimulated by obtaining increased yields per acre.

150. Crop Prospects. (*Cott. and Genl. Econ. Rev.*, 4/2/49.) Dry season weather of greater than normal severity prevailed in all areas during December. Development of almost mature cotton was hastened and picking began. Grade and quality were variable, being good in the Buganda Province, but poor in the Eastern and Western Provinces at first, though later improvement occurred. Yields of early cotton are generally good, but August plantings suffered arrested development, and their yields and the quality of the cotton will be impaired. The estimate of the total crop is reduced to 340,000 running bales.

151. Cotton Crop. (*E. Afr. and Rhod.*, 23/12/48, p. 493.) The whole of the forthcoming cotton crop in Uganda, estimated at about 350,000 bales of 400 lb., has already been sold. The British and India Governments had agreed that the first 250,000 bales should be made available in the proportion of 175 to 75 to the Raw Cotton Commission and to Indian interests respectively, and representatives of the two parties are now in Uganda for the purpose of arranging the prices to be paid. In the absence of the free market which was previously available in Liverpool, the Government of Uganda had to decide how to dispose of the balance of approximately 100,000 bales. As an experiment, it was decided to invite private tenders for a maximum of 10,000 bales daily. So successful was the method that the whole of the balance was bought forward in less than a fortnight at the high average price of 28d. per lb.

152. Mills for Jinja. (*E. Afr. and Rhod.*, 23/12/48, p. 495.) Licences have been granted to the Calico Printers' Association of Manchester for the establishment of a cotton piece-goods mill in Jinja, and to an Anglo-Belgian group for a cotton blanket factory in the same area of Uganda.

153. The Owen Falls Project. (*E. Afr. and Rhod.*, 17/2/49.) The Egyptian Government have announced their willingness to participate in the project of a dam and hydraulic works at Owen Falls near Jinja in Uganda. The project embraces several schemes, and it will be many years before they can all be carried out. The initial scheme will transform Lake Victoria into a vast reservoir for "century" storage, the water being raised to 1·3 metres above the maximum recorded level. The Egyptian Government will contribute £E4,000,000 and the Uganda Government £8,000,000 to this work. Egypt will get the benefit of assured supplies of water for irrigation, and Uganda will get an electricity supply that can be made the basis for varied industrial development. Another scheme would enable the Sudan to expand the Gezira cotton-growing scheme which at present extends to about 1,000,000 acres. It is estimated that a further 1,500,000 acres could be irrigated if the water were available.

154. AUSTRALIA. Queensland: Cotton Industry, 1947-48. (*Ann. Rep.*

Dpt. Agr. and Stock, 1947-48.) The Report opens with a review of the work carried out by the Department during the past 10 years. Work undertaken by the Division of Plant Industry consists largely of the development of better crops and pasture plants, the elaboration of better methods of crop and pasture production and the dissemination of knowledge among the farming community. In 1947 a Soil Conservation Section was established within the Division and a number of farm demonstration projects have been set up with the threefold object of training staff, demonstrating the soundness of the recommended measures and obtaining additional information. The incidence of intense storm rainfalls characteristic of the Queensland summer creates special problems in soil erosion and necessitates a good deal of investigation work to ensure the development of the best practices for Queensland conditions. For more than 20 years an experiment station and the services of a considerable field staff have been devoted to the production problems of the cotton crop. Following on extensive investigational work on varieties, cultural methods, irrigation practices, and pest control, the foundation has been laid for the development of an agronomically sound cotton-growing industry in Queensland. The industry could achieve important status in Queensland given equitable price treatment in regard to competitive crops. Improved varieties and a vast amount of technical knowledge are available should the industry be resuscitated by satisfactory guarantees.

The 1947-48 cotton crop was the lowest recorded for many years. The low financial returns from cotton compared with the present high prices for other agricultural produce, and, to some extent labour shortages, are probably the most important factors contributing to this unfortunate result. Low yields were the rule in most districts, and in this connection the prolonged dry periods in midsummer and late summer were important factors. So much shedding occurred during these dry periods, and good rains came so late in summer that the plants were unable to recover. District average yields were in the vicinity of 300 lb. per acre in some cases, though a small number of plantings yielded much better.

The Biloela Regional Experiment Station plantings comprised a hybridization plot, increase plots for hybrid progenies, and jassid resistant Miller selections, strain trials, and drought resistance trials. The hybrids were based on the jassid susceptible varieties Lone Star, Triumph, New Mexico Acala, and Miller as the one parent, and one of the highly resistant varieties such as Ferguson or a Rhodesian strain as the other. A small plot was planted on a sandy well-drained soil in order to determine whether there was evidence of correlation between hairiness and drought resistance. The results suggested that the hairy varieties Lot I and Umil 12 may, even in the absence of Jassids but under conditions of water stress, produce and retain more bolls per plant than the current commercial Miller. In the varietal selection plantings, the new introduction Locket, grown under irrigation on a sandy alluvial soil at Gayndah, yielded more than 2,000 lb. of seed cotton per acre; the variety proved most prolific and the fibre was of good length and uniformly strong. Selection was directed towards suitability for mechanical harvesting. A test was made of the one-row mechanical cotton picker manufactured by the International Harvester Co. of America. Unfortunately the machine did not arrive until June, and consequently the trials had to be conducted in a crop little suited for machine harvesting. The results of the trials were so encouraging, however, than an extensive trial of the machine is planned for the coming season.

155. WEST INDIES. Report of the Advisory Committee in England of the West Indian Sea Island Cotton Association, 1948. The report states that the outlook for the industry is not unfavourable. Sales were arranged on a bulk buying basis with the Raw Cotton Commission in advance of the cotton planting season, and this policy is expected to have extensive repercussions. Prices have risen for all grades, though in view of the increasing competition of the finer growths of Egyptian cotton it seems unlikely that the high prices will be maintained. As a result of this competition it is suggested that the M.S.I. type cotton now grown exclusively in the Leeward Islands might be changed for a cotton with a longer

and finer staple. The Committee urged that the question of the alleged deterioration of M.S.I. grown in Nevis and Antigua should be examined in detail.

The setting up of different standards of M.S.I. cotton from the various Islands by the Raw Cotton Commission is viewed with great dissatisfaction in the West Indies, and it was agreed that the chairman should take up with the Commission the advisability of having one scale of grades for M.S.I. cotton from all the Islands. Mr. P. W. Briggs' report on the conditions in ginneries in the West Indies was considered, and the Committee endorsed the proposals made therein, especially with regard to the licensing of ginneries and their regular inspection. It was noted that experimental work in progress at the Central Cotton Station in Antigua and other stations has already given interesting indications of ways in which the yield of cotton can be improved, and the Committee recorded their appreciation of the work carried out by Mr. Lochrie, and of the assistance of the Empire Cotton Growing Corporation in this matter. The report concludes with mention of advertisement and propaganda for Sea Island goods, and displays set up at industrial and general exhibitions.

156. Agricultural Research in the West Indies. By G. C. H. Thomas. (*Crown Colonist*, Jan., 1949, p. 18.) In 1945 the United Kingdom Government approved, under the Colonial Development and Welfare Act, a scheme for the establishment of an experiment station at Camden Park which, in addition to investigating problems concerning arrowroot, food production, pasture improvement and livestock development, should continue the work on superfine St. Vincent cotton previously carried out at the experiment station maintained in St. Vincent by the Empire Cotton Growing Corporation.

The Camden Park Station controls the seed supply of cotton for the commercial crop, and by selecting and multiplying only superior progenies, ensures that the cotton reaching the market comes from only the best seed possible, and in this way safeguards the high reputation of St. Vincent superfine cotton. Experiments to increase the yield of St. Vincent cotton which were initiated by the Empire Cotton Growing Corporation are being continued and much progress has been made in this work. Though not yet available for commercial production, strains of a type which combines the length and fineness of V. 135 (St. Vincent superfine) with the ginning outturn of M.S.I. (Montserrat Sea Island) have been evolved from hybrids of these varieties.

157. Report of the British Guiana and British Honduras Settlement Commission. (Cmd. 7533. H.M. Stat. Off., 1948. Price 7s. 6d.) It is suggested that Sea Island cotton might be grown in rotation with sugar cane in certain areas, most particularly in the northern area of the Corozal District, where certain experiments on cotton-growing were carried out some years ago. While it is realized that large-scale production would have to wait more extended utilization by manufacturers of this long-staple cotton, there is little doubt that present markets could readily absorb some hundreds of bales in excess of the present supply from the Leeward and Windward Islands, provided that the price and quality were satisfactory. Present indications are that there is a demand for at least 1,000 bales of 480 lb. annually. Since about 120 lb. of lint are produced on the average from one acre, this would imply that a total area of 4,000 acres might be devoted to the crop. It is recommended that trials should be made of V. 135, Superfine, from St. Vincent and M.S.I. from Montserrat to determine the type of cotton best suited to the conditions. Particular attention should be paid to the incidence of insect pests, which may prove to be a limiting factor to large-scale development of the crop.

158. Montserrat: Cotton Prospects. (*West India Comm. Cir.*, Dec., 1948, p. 262.) The 1948 season is reported to have been favourable for cotton in Montserrat, in marked contrast to the two previous years, and an early start to the planting season resulted in the shipment of 700 bales as early as September 10. The year's crop is expected to be not far short of 600,000 lb. of clean lint.

COTTON IN THE U.S.A.

159. AMERICAN COTTON CROP, 1948: FIBRE AND SPINNING TEST RESULTS. (U.S. Dept. Agric., Production and Marketing Admin. Cotton Branch, 1948. From *J. Text. Res.*, xxxix, 12, 1948, p. a598.) Fibre and spinning test results are presented for some pure varieties of cotton grown commercially by selected cotton improvement groups in 1948. The selection of areas and samples and the test procedures are described. Test results for samples selected from early and mid-season harvests of the 1948 crop in south Texas are tabulated and include data with respect to the qualities of raw cotton selected for testing, results of the fibre laboratory tests (fibre length, fineness, maturity, strength), and data on manufacturing performance and product quality. A detailed explanation of the various tests and the basis for evaluating test results is given.

160. COTTON ACREAGE ALLOTMENTS. (*Cotton*, M/c., 5/2/49.) One of the problems confronting the Department of Agriculture at the present time is with regard to the formula to be used for calculating acreage allotments in coming seasons. The present law governing this situation needs to be amended, since its provisions for the calculation of allotments are out of date and would result in inequities among farmers and producing areas. Planting allotments and marketing quotas have not been in use since the 1942 crop, and will not be in use on the 1949 crop. However, it appears quite likely that they may have to be applied to the 1950 crop to prevent over-production. In looking forward to this possibility one of the major questions to be decided is whether or not the 1949 cotton acreage should be taken into consideration in determining the base period to be used in the calculation of future allotments. A representative of Mississippi has already introduced a bill which provides for the elimination of the 1949 planted acreage from whatever base period may be decided upon. He feels that his bill will discourage cotton growers from planting any excess of acreage this year. On the other hand, a representative of California is urging that 1947, 1948 and 1949 acreages be used in determining a base for allotments in 1950, if allotments should be necessary at that time. He points out that California should not be put to a disadvantage on acreage allotments just because it has greatly expanded its production in recent years.

161. AMERICAN COTTONS: PROPERTIES. By P. M. Thomas. (*Text. World*, 98, 10, 1948, p. 107. From *Summ. Curr. Lit.*, xxix, 1/2, 1949, p. 5.) The value of cotton breeding is stressed and illustrated by the development of the Acala 4-42 variety. The importance of the leading eight American varieties is explained—they account for 80 per cent. of U.S. production. An account is given of fibre properties, and their dependence on external factors. Tabulated fibre property and manufacturing performance data are presented in a large folded "Cotton Fiber Table" for the Deltapine, Stoneville 2B, Coker 100, Acala 1517, Acala P 18C, Acala 4-42, Hibred and Rowden varieties. Fibre and fabric production tables and price lists are included.

162. AMERICAN COTTONS: PRICES: EFFECT OF GOVERNMENT PRICE SUPPORT. By D. Loomis. (*Text. Wld.*, 98, 10, 1948, p. 107. From *Summ. Curr. Lit.*, xxix, 1/2, 1949, p. 19.) The author gives a detailed explanation of the Congress and Senate sponsored measures for Government support for cotton prices. For 1950, a lower parity price than in 1949 (by 13 per cent.) is to be accompanied by 60 to 90 per cent. support. Tabulated price data demonstrate the effect of these measures.

163. UNITED STATES FINE SPINNING MILLS AND THE SUPPLY OF LONG-STAPLE COTTON. (*Cotton*, M/c., 19/2/49.) The trend of the cotton crop away from long staple cottons has made it exceedingly difficult for the fine combed fabric and yarn mills to secure adequate supplies of cotton. The growers, even in those areas that normally produce staple cottons, have apparently found it more profitable to plant the shorter staple, early maturing, high yielding varieties. While this practice has improved the average staple of the crop, it has also practically eliminated the United States supply of long staple cotton. Under the quota system, if the combing mills operate anywhere near capacity, it immediately becomes necessary to secure larger quantities of imported cottons. Last year President Truman authorized

the importation of 18 million additional pounds of Egyptian long staple cotton under the quota. The shortage of staple cottons raises a serious question in national defence. In a military programme a large part of the requirements are manufactured from long staple cottons. For this reason an adequate supply of such cotton should be on hand at all times. It would seem only sensible that the Government stockpile of long staple cotton should be sufficient to take care of any emergency programme for at least two years, the approximate length of time needed to grow and harvest a domestic crop of any size.

164. GEORGIA: COTTON BREEDING. (*27th Annual Report of the Georgia Coastal Plain Exp. Sta.*, Tifton, 1946-47, Bull. 44. From *Pla. Bre. Abs.*, xviii, 4, 1948, p. 637.) The new wilt resistant variety of Upland cotton, Pandora, is to be increased. It is an early variety, and in fibre properties has proved superior to most commercial varieties tested at Tifton. Selected lines showing promising yielding capacity and fibre properties are under observation, many of which will be crossed with Pandora, to effect further improvement in this variety. Crosses of pure varieties or inbred lines of Upland cotton are under investigation with regard to hybrid vigour. A new strain of Sea Island cotton, developed from a cross between Puerto Rican and Gaddis Sea Island, has given high yields; its staple length is about 1⅝ in., and its fibre possesses relatively high tensile strength. In addition to the production of new Sea Island strains, hybrids between Egyptian and Sea Island are under investigation.

165. PUERTO RICO: INDUSTRIAL DEVELOPMENT OF PUERTO RICO AND THE VIRGIN ISLANDS OF THE UNITED STATES. *Report of the U.S. Section, Caribbean Commission*, 1948.) Cotton production in Puerto Rico has varied widely during the past ten years, rising to 2,065 bales in 1941 and falling to 97 bales in 1946. The cotton is of good quality and long staple, but local production, even in its best years, is insufficient to support local spinning. Exports of unmanufactured cotton have also varied widely in annual values. The highest export value attained was in 1932 at $713,342 and the lowest in 1935 at $6,738.

166. SOUTH CAROLINA: COTTON BREEDING. (*59th Ann. Rep. Sth. Carolina Exp. Sta.*, Clemson Agric. Coll., 1945-46. From *Pla. Bre. Abs.*, xviii, 4, 1948, p. 629.) Breeding was continued for earlier, more productive Sea Island cotton sufficiently resistant to boll weevil, and for cottons with longer, stronger fibres which are as productive as standard types with a 1¼ in. fibre. Tanguis, Egyptian, Sea Island and wild types from Florida were used in crosses. Sealand 542 is one of the best long staple varieties which have been obtained. It was selected in 1943 from the third generation from the fourth back cross of Bleak Hall (Sea Island) × Coker-Wilds on Coker-Wilds. The characteristics of the two original parents are indicated and the history of the development of Sealand 542 is described in detail. This strain has very strong fibre and good staple. It was productive in 1943, 1944, 1945 and 1946 and was to be included in varietal tests in 1947. In tests of Sea Island strains, conducted on Johns Island in 1946, the hybrid YR and Seaberry each yielded 1,275 lb. of seed cotton per acre, Seaberry being the earlier of the two. Conga yielded 1,213 lb., Mondis 1,173 lb. and Seabrook 972 lb. per acre. In the Leesburg tests Mondis was the highest yielding with 1,747 lb. per acre, while Conga gave 1,631, Seaberry 1,560, Seabrook 12B2 (control) 1,467 and YR 1,380 lb. per acre.

COTTON IN EGYPT

167. EGYPT: EXCHANGE CONTROL. (*Cotton*, M/c., 5/2/49.) A recent edict of the Egyptian Exchange Control has caused depression in Alexandria as being a further impediment to the successful conclusion of business abroad. It is now ruled that all payments in sterling for cotton shipped to any country must be made with funds drawn from that particular country's account. Previously sterling, from the United Kingdom for example, provided it was transferable, had been permitted to finance shipments of cotton to other countries, but this is now forbidden.

168. RAW COTTON EXPORTS. (*Cotton*, M/c., 12/2/49.) Raw cotton exports from

Egypt from September 1, 1948, to February 3, 1949, total 399,458 bales, compared with 405,299 bales during the corresponding period in the previous season. Great Britain accounted for 152,798 bales against 42,700 bales, the Continent 134,053 bales against 254,406 bales, India, China and Japan 107,256 bales against 74,415 bales, and the United States of America 5,351 bales against 33,778 bales.

169. The Egyptian Cotton Gazette. The contents of Vol. 5, September, 1948, include the following: "Prospects for the 1948-49 Cotton Season" (D. Windel); "Egyptian Cotton in Italy" (P. Bellora); "The Franco-Station Contract" (C. Antonius); "The Alexandria Futures Market" (C. R. Barber); "Economics of Egyptian Cotton" and "Commercial Yarn Strengths Cotton" (C. H. Brown); "Cotton Pressing in Egypt" (A. O. Samson); "Cotton Bale Enquiry"; "Manuring of Egyptian Cotton" (T. Zaliki); "A Novel Improvement for Regulating the Lap Feed in Textile Cards"; "Jumel—A Frenchman in the Service of the Great Mohammed Aly"; "Cotton News"; "The Statistical Position of Egyptian Cotton at 31st August, 1948" (R. Dabbous). Various statistical tables and diagrams are also included.

COTTON IN OTHER FOREIGN COUNTRIES

170. Argentine: Cotton Crop. (December Commentary, Inter. Cott. Adv. Comm., 1948.) There are indications that plantings in Argentina for the crop to be harvested in 1949 will be larger than in the preceding season. Ginnings for the period August 1947 through July 1948 totalled 412,000 bales. It is reported that the Government has decided to purchase several cotton harvesting machines from the United States in an effort to overcome shortages of labour for harvesting. The National Commission for the Establishment of Industries recently announced the prospective establishment of seven new textile mills. Apparently these concerns are being moved from some other country. At least one of these provides a further outlet for cotton, being a manufacturer of canvas and sail cloth. Latest reports indicate a continuation of the upward trend in cotton consumption which last season amounted to 372,000 bales.

171. Belgian Congo: Cotton Crop. (November Commentary, Inter. Cott. Adv. Comm., 1948.) Preliminary estimates of the crops falling within the 1947-48 international season indicate a total of 184,000 bales, which is 4,000 bales larger than in the previous season. In northern provinces the crop has been particularly good. The two local textile manufacturing companies absorb about 25,000 bales annually. The area planted for harvesting in the 1948-49 season is reported at 305,000 hectares, which is somewhat larger than in the previous year.

172. Brazilian Cotton. (*Cotton*, M/c., 8/1/49.) Advices from Brazil indicate that the acreage planted to the staple in South Brazil will be about 2,582,000 acres, or approximately 25 per cent. larger than the 2,066,000 planted in 1947. Assuming favourable growing and harvesting conditions, close to 900,000 bales of 478 lb. each are expected to be produced, or about 260,000 more than the 1947 production of 760,000 bales, and slightly above the 1946 production. However, the current expectation is considerably less than the crops produced in South Brazil during the five seasons from 1940-41 through 1945-46, which ranged from a high of 2,211,000 bales in 1943 to a low of 1,142,000 in 1944. Some of the factors which are contributing to a revival of interest in cotton production this year are improved farming and control of insects and pests; development of new and better varieties of seed; the attractive price level during the past season and prospects for a continuation of good returns; the promise of a more liberal policy for financing cotton production; the lower returns from competitive crops, resulting in diversion to cotton of land formerly planted to other crops. With the crop in North Brazil expected to be about 365,000 bales, the total production for all Brazil appears to be in the neighbourhood of 1,265,000 bales, as against 1,175,000 for last season and 1,310,000 two seasons ago. The total supply for the current season, however,

placed at 2,550,000 bales is about 600,000 bales less than was the case a year ago, and about 1,800,000 bales under two years previous.

173. CHILE: COTTON CULTIVATION. (*Cotton*, M/c., 1/1/49.) It is reported that at the instigation of the Minister of Economy and with a view to saving foreign exchange, a study is to be made of the possibilities of growing cotton in Chile. It is understood that a company will be formed shortly and that leading textile industrialists are actively interested. Valleys in the extreme North of the Country and in the Central Zone—the latter provided they are not subject to spring or summer frosts—are thought to be the most probable experimental areas.

174. FRENCH EQUATORIAL AFRICA: COTTON SEASON, 1947-48. By R. Legendre. (*Coton et Fibres Trop.*, 3, 3/4, 1948, p. 123.) The 1947-48 crop in the Ubangui and Chad areas reached a total of 23,597 tons of seed cotton, thereby showing an increase of nearly 30 per cent. over the 1946-47 crop which totalled only 16,922 tons. Weather conditions were generally favourable and losses from insect pests and diseases were small. Much credit, however, must be given to the cultivators and administrators. It is hoped to increase the crop still further by improved methods of cultivation and more effective pest control, and by the extension of the area devoted to the crop. It is thought that nearly the whole of the Ubangui-Chari district is suitable for cotton cultivation, and it is hoped that the total crop will reach 100,000 tons of seed cotton annually.

175. FRENCH EQUATORIAL AFRICA, NOTES ON COTTON CULTIVATION IN. By E. O. Pearson. (*Coton et Fibres Trop.*, 3, 3/4, 1948, p. 61.) In January, 1948, Mr. Pearson, the Senior Entomologist of the Empire Cotton Growing Corporation, visited the cotton-growing areas of Chad and Ubangui in French Equatorial Africa. The author gives a general survey of the types of soil characteristic of the areas through which he toured, and the regional climatic conditions. He then describes how cotton cultivation is fitted into local agricultural systems whereof cotton and groundnuts are the only cash crops. The crop is purchased at government controlled prices by commercial companies, having concessions in certain areas. Transport is a difficult problem; the distances to be traversed by road and river are great, and roads are frequently impassable except during the dry season, the Benoue and Garoua Rivers then being unnavigable. The commercial crop is made up of varieties of American Upland, chiefly Triumph and Allen. As much of the crop had been harvested prior to his visit, the author was unable to report fully on the position regarding damage by disease and insect pests. In Ubangui, considerable loss is caused by bacterial blight (*Xanthomonas malvacearum*). Among the pests, jassids (*Empoasca sp.*), *Helopeltis sanguineus*, *Diparopsis castanea* and *Platyedra gossypiella* are the most serious, and the author suggests possible methods for their control.

176. PARAGUAY. (I.C.A.C.—Nov. Rep. *Cott. and Genl. Econ. Rev.*, 10/12/48.) It is estimated that about 136,000 acres will be planted to cotton and that production in 1948-49 will amount to some 56,000 bales. Last season the crop, which totalled 46,000 bales, was badly damaged by insects and drought. Progress is expected to be made in combating insects and more normal yields are anticipated this season. Since cotton is one of the country's leading export crops and a source of edible oils, Government efforts in the agricultural field are being concentrated towards increasing production. Some increase is also likely in domestic consumption of cotton in 1948-49. Two mills are importing new machinery and a rayon mill was due to be completed by the end of 1948. Consumption in 1947-48 amounted to about 7,000 bales, which was treble the pre-war figure.

177. PERSIA. (*Cott. and Genl. Econ. Rev.*, 12/11/48.) It is part of the Government's policy to stimulate production of cotton and improve its quality. The area planted to cotton for the 1948-49 season is estimated at 116,000 hectares, which is 40 per cent. greater than last season. Growing conditions have been generally favourable, although locust damage and insufficient rainfall are reported to have adversely affected yields in the Caspian provinces. Yields are higher in western and southern provinces, where production has only recently been resumed. The total crop is forecast at 115,000 bales for 1948-49 as compared with about 80,000 bales in 1947-48.

178. PERU. (*Cott. and Genl. Econ. Rev.*, 14/1/49.) Reports on the 1947-48 production in Peru indicate that the crop is the smallest since 1942-43 and amounted to only 275,000 bales instead of 301,000 as reported earlier. Acreage harvested, estimated at 321,000 acres, is larger than the 309,000 reported for 1946-47. Heavy insect damage was mentioned as the principal cause for reduced yield in 1947-48. No estimate is available for 1948-49, but the Peruvian Government's requirement that at least 15 per cent. of the cultivable land on many of the large farms be planted to food crops is still in effect and may limit the area to approximately the 1947-48 figure.

179. PORTUGAL. (Gre. Nac. dos Import. de Alg. em Rama. From *Cott. and Genl. Econ. Rev.*, 10/12/48.) The contribution of the African Colonies to the supply of raw cotton for the home market, which up to 1932 was always less than 10 per cent., increased by 1943 to almost 90 per cent. During the last five years, Angola and Mozambique together exported a yearly average of more than 24,000 tons, and all this cotton was consumed by the Portuguese textile industry. Annual requirements of long stapled cotton, which is not yet produced in the Colonies, are only 100 to 200 tons, so that a sufficient national supply is almost attained.

The quality of the Colonial cotton is fairly good. The average staple of Mozambique cotton is $1\frac{1}{8}$ in. Angola cotton is a little shorter, varying from $\frac{15}{16}$ in. to $1\frac{1}{8}$ in. Yields are rather low—190 lb. of seed cotton in Mozambique and 199 lb. in Angola are obtained on average per acre. On the other hand, costs of production are high—a situation which must appear strange in a country where land has so little value, manual labour is abundant and cheap, and climatic conditions are apparently favourable to cotton-growing. The reasons for this are diverse. Firstly, cultivation is done by natives with a primitive standard of life; secondly, the harvest is done entirely by hand without the aid of any agricultural implements; thirdly, cultivation is effected by natives on small plots of ground of about two acres; and fourthly, there is a lack of meteorological information which would allow the definite selection of the most suitable cotton-growing areas. Moreover, the devastation caused by such insects as grasshoppers and caterpillars is sometimes enormous. All Colonial cotton is rain-grown, as irrigation has not yet been developed. In certain zones, rainfalls are too abundant, in others deficient or irregular. Transport by land or water is excessively costly. All these problems are now being tackled by the authorities concerned and some of them are almost resolved. The aim is to supply fully the Metropolis with suitable cotton produced in the African Colonies, and the end is not far from attainment.

180. PORTUGUESE EAST AND WEST AFRICA. (November Commentary, Inter. Cott. Adv. Comm., 1948.) Trade sources report that the 1947-48 crop in Angola and Mozambique has been disappointing. Efforts are being made to improve cotton cultivation in both colonies but unfavourable weather has delayed maturity and damaged crops. In Angola production will show an appreciable decline to probably only 15,000 bales, and in Mozambique the crop, at 99,000 bales, is expected to be about 10 per cent. smaller than in the preceding season.

181. RESULTS OF EXPERIMENTS CARRIED OUT IN THE COTTON-GROWING REGIONS OF BAIXO BUZI, MOZAMBIQUE. By L. Salazar de Eca. (Centre for the Sci. Invest. of Cotton, *Separate* 52, 1947. In Portuguese.) This bulletin deals with investigations carried out by the Centre in co-operation with the Companhia Colonial do Buzi. The number of years of meteorological records is inadequate, but graphs are given in respect of the available data from 1939-45. As a result of cultivation trials it is held to be desirable to replace the local variety as soon as possible by a more productive strain with appreciable fibre characteristics. Among the best classified is without doubt the strain 5143. Other trials showed that the best spacing was $1{\cdot}00 \times 0{\cdot}80$ m. with one plant per hole. However, the opinion is expressed that $1{\cdot}00 \times 0{\cdot}80$ with 2 plants per hole should be adopted until these results are confirmed by further experiments. It is calculated that the alteration in the present measurements, as recommended by this test, would produce an increase in yield of about 20 per cent. in the region of Baixo Buzi.

182. Russia: Cotton Crop. (*Ambassador*, 1, 1949, p. 128.) The 1948 cotton crop in the U.S.S.R. is reported to be good, in spite of rather bad weather conditions. In 1947 heavy losses of raw cotton were incurred because of late harvesting, but the situation seems to be slightly improved this year; there are, however, considerable delays in certain areas, and in September the delivery plan was not fulfilled in either Uzbeckistan (which accounts for about 80 per cent. of the cotton crop) or Turkmenistan.

The Council of Ministers, endeavouring to prevent a recurrence of the 1947 losses, have adopted a resolution that growers must harvest not less than 85 per cent. of their crop by November 1, finish harvesting by November 25, and complete deliveries by December 1. This date is at least a month earlier than it has been in previous years.

183. Azerbaijan American and Egyptian Cottons. (Sci. Rep. Azerbaijan Cott. Res. Inst., 1941/42, Moscow, 1946. From *Summ. Curr. Lit.*, xxix, 1/2, 1949, p. 1.) An outline is given of cotton breeding by the Azerbaijan Research Institute for Cotton since 1926, of the methods used, and of the performance of the varieties obtained in various trials in Azerbaijan. The most promising Upland cottons bred are 0155 and 01363; both are wilt resistant and of good quality. Hybridization has been employed mainly to obtain early varieties. The variety 4768-1 has proved in Azerbaijan to be the highest yielding Egyptian cotton tested and is 3-4 days earlier than Fuadi. It is resistant to virus disease and does not suffer from shedding of the lint. It is suitable for mechanical harvesting. In lint quality it resembles Fuadi, but has somewhat longer fibres and a lower metric number. Results of hybridization of Sea Island varieties with early Egyptian cotton are reported.

184. Turkey. (*Cott. and Genl. Econ. Rev.*, 12/11/48.) The area in cotton cultivation for the 1948-49 crop is estimated at 281,000 hectares as compared with 214,000 in 1947-48—an increase of 30 per cent. Production in 1947-48 was about 220,000 bales. Consumption in the 1947-48 season is estimated at 194,000 bales, including 37,000 bales used in households. Stocks, which have been steadily mounting in the past five years, reached 100,000 bales by the end of last season. Until recently exports were permitted only through official channels and only in exceptional circumstances. With a much larger supply in prospect, however, the Government has announced that private concerns may now sell cotton in world markets. Prices in the 1947-48 season were fixed by the Government, but no announcement has been made concerning prices for the current season.

185. Objectives and Organization within the Framework of the Department of Agriculture of the Cotton Investigation Department. By N. Turgay. (*T.C. Tarim Bakanligi Dergisi*, 1, 3, 1947, p. 18. From *Pla. Bre. Abs.*, xviii, 4, 1948, p. 763.) In 1937 a Department for Cotton Investigation was set up under the direction of the Turkish Minister of Agriculture for promoting cotton cultivation. At present there are two parent institutions at Adana and Nazilli, two branches at Eskisehir and Malatya, and this year a breeding farm was opened at Manisa, besides various farms dependent on the parent institutes.

From 1931 onwards, improved cotton varieties, imported from the U.S.A., were given comparative trials; at first, Cleveland in the northern province and Acala in the Ægean district gave the best results and, accordingly, the sowing of these varieties was made compulsory and the old open-bolled cotton varieties were prohibited. In 1939 tests with seed, also imported from the U.S.A., showed that Acala gave the best results in the northern district also, and from 1943 onwards the Cleveland variety was also suppressed. The regions formerly growing open-bolled cottons changed over to Acala, and trials were continued on this variety and also on some of the native close-bolled cottons. From 1935 to the present time, 5,880 tons of pure seed of Cleveland and over 8,000 tons of Acala have been distributed.

Systematic investigations on native cottons have given favourable results and a new high-yielding native variety, with good quality fibre, has been launched under the name of Y. 193. As was done with Acala, in order to raise the standard of purity and quality of the seed reserved from improvement experiments, the earlier

maturing and higher yielding types were set apart and tested for breeding purposes. Special cotton selector machines were imported from U.S.A. and set up at the main centres; the purity of a great quantity of cotton seed was improved by passing through these machines.

SOIL, SOIL EROSION AND FERTILIZERS

186. PERSISTENCE OF DDT AND BENZENE HEXACHLORIDE IN SOILS. By M. S. Smith. (*Ann. App. Biol.*, **35**, 4, 1948, p. 494.) Acid and alkaline soils, both alone and mixed with 2 per cent. of DDT or 2 per cent. of benzene hexachloride (mixed isomers, containing 10 per cent. of the γ-isomer), have been exposed outdoors or subjected to controlled leaching in the laboratory. Residual insecticide has been estimated at intervals by a method involving dehydrohalogenation, and determinations have also been made of chloride content of soil, chloride leached and *p*H. Results showed that both DDT and benzene hexachloride were very stable in the soils, about 95 per cent. of the former and 80 per cent. of the latter being recoverable after 18 months. Very little chloride was leached during this period. The residual insecticide exhibited marked toxicity towards woodlice. Eighteen months after treatment the benzene hexachloride soils prevented root growth of germinating seeds, while germination and early growth were normal in the DDT soils. This harmful effect of the residual benzene hexachloride was still apparent when 1 part of the treated soil was mixed with 99 parts of the control soil (representing a concentration of less than 0·002 per cent. of the γ-isomer).

187. THE COMPOSITION AND USE OF KAROO MANURE. By E. R. Orchard and R. Ludorf. (Dept. Agric. S. Afr., *Bull.* 298, 1948.) The rapid war-time expansion in the manure trade is discussed and a detailed survey of the main production and consuming centres is given, based as tonnages transported by the S. African Railways. The average composition of Karoo manure in respect of moisture, loss on ignition, nitrogen, phosphoric oxide, potash and brak salts is shown for the Karoo as a whole and also for grouped samples from the four subdivisions of the Karoo. Under S. African conditions Karoo manure is used to best advantage in fruit and vegetable producing areas where the valuable nitrogen constituent can be efficiently utilized by crops. On account of its relatively low P_2O_5 content, Karoo manure is not an ideal dressing for maize. If used for this purpose it should be supplemented with mineral phosphatic fertilizers. Although the manure is rich in potash, this constituent is of doubtful value when applied under average South African conditions. A comparison is drawn between the value of milled and crude manure which shows that the farmer receives 75 per cent. better value for his money when buying the latter. An attempt is made to arrive at the true agricultural value of a ton of manure of average composition. It is shown that at 14s. per ton for crude manure the farmer buys fertility comparatively cheaply. The nitrogen and potash sold annually in the form of manure form a very significant proportion of the total amount of these plant foods applied to the soil. In the case of P_2O_5, however, the fertilizer trade in super and other mineral phosphates completely dominates the picture. The composition and relative merits of farm compost, municipal compost, kraal manure and Karoo manure ash are discussed.

188. FERTILIZER MANUFACTURE IN EAST AFRICA. (*Nature*, **162**, 4118, 1948, p. 522.) A scientific mission from East Africa is at present on a short visit to the United States to study the methods employed by the Tennessee Valley Authority in the manufacture of fertilizers. Large deposits of rock phosphates are known to exist in Uganda, and it is expected that the knowledge gained from this visit can be applied to the exploitation of these deposits when hydro-electric power becomes available from the Owen Falls scheme. The members of the mission are: Dr. A. J. V. Underwood, industrial consultant in London to the East Africa High Commission; Mr. H. B. Stent, acting chairman of the East African Industrial Research Board; Dr. K. A. Davies, director of the Geological Survey, Uganda, and Mr. C. R. Westlake, chairman of the Uganda Electricity Board.

189. INVESTIGATIONS OF THE VARIATIONS IN THE SOIL STRUCTURE AT YANGAMBI, BELGIAN CONGO. By J. d'Hoore and J. Fripiat. (I.N.E.A.C., *Ser. Sci.*, 38, 1948. In French.) It was observed that plant rootlets exerted a peptizing action on flocculated soil colloids. A method is described for the determination of the peptized and flocculated colloid content of soils, without altering the natural properties of the colloids. The reagent used is a 20 per cent. mixture of carbon tetrachloride in methyl alcohol. The specific surface (*So*) of the fraction $<297\mu$ is considered as a measure for the structural units of the soil. *So* is calculated from the permeability for air. The authors found a well-controlled mathematic correlation between *So* and the peptized and flocculated colloid contents of the structural units. The equation enabled them to distinguish between different soil types; moreover it contains a constant value that measures the action of vegetal associations on a given soil colloid type. They used their techniques in the study of fallow problems and some first results are given.

190. RESPONSE OF THE COTTON CROP TO SOIL TYPES IN WARANGAL SUBHA. By V. N. Poornapregna and D. V. Narayanayya. (*Ind. Cott. Grwg. Rev.*, ii, 3, 1948, p. 130.) Results obtained from a series of varietal trials with cotton conducted on *chalka* and *regur* soils at the Government Farm, Warangal, show that as good or better crops of cotton can be grown on *chalka* as on *regur*. The yield on either of the two soils is generally determined by the quantity of rain received in July-August. A rainfall of 18 to 22 inches in years of heavy rainfall is favourable to the cotton crop on *chalka* soil, while a total of 8 to 11 inches in the same months in years of low rainfall is conducive to higher yields on *regur* soil. The comparatively low yield on *regur* in heavy rainfall years can be attributed to the initial retardation of crop growth and the loss due to " root rot " mortality in July, and the shedding of early formed buds in August. On *chalka* soil, due to better drainage and optimum moisture being available to the crop, the yield is higher. The quality of cotton (fibre properties and spinning value) of the local as well as of the improved varieties was not affected by the type of soil.

From the data avilable, it appears that in view of the differential response in yield on the cotton crop to the two soil types in Warangal Subha, it would be advisable, in the event of a possible increase of cotton area after the present food crisis has passed, to distribute the area under cotton cultivation equally to both soils. This will assure the maximum production of cotton from season to season.

STATISTICAL TREATMENT, CULTIVATION, GINNING, ETC.

191. GRAPHIC CORRECTION OF A FISHER EXPERIMENT. By G. Hamming. (*Landbouwk. Tijdschr. Wageningen*, 59, 1947, p. 496. From *Pla. Bre. Abs.*, xviii, 3, 1948, p. 413.) The results of an experiment published by Wishart and re-analysed by Yates are corrected on the basis of fertility contours. Wishart and Yates eliminated fertility on the basis of a Latin square although it was not one, which forced them to use innumerable errors in one experiment. The fundamental idea, that the fertility is not orthogonal to the layout, is the same as Yates's. Yates, however, corrected the fertility orthogonally and left the actual experiment non-orthogonal. Here, on the other hand, the fertility is corrected non-orthogonally. The analysis of variance for treatments is then orthogonal, and the error variance is reduced to $\frac{1}{3}$ of Yates's figure. Methods for estimating the degrees of freedom involved in these corrections are worked out, thus: "For row 41 the fertility is -17; this figure is entirely independent of the rest and therefore requires 1 degree of freedom. The fertility of rows 43-53 is constant 0, this is one figure and requires 1 degree of freedom. The fertility of 55 is 7, a fairly random amount, count 1 degree of freedom for it. The figures for 57-63 lie on a straight line, this requires 2 degrees of freedom. Thus in total 5 degrees of freedom have been used. But this calculation is not completely accurate. The sum of all the fertility deviations is *a priori* equal to 0. Thus 1 degree of freedom less has been used than we assumed. But perhaps we have overlooked one, therefore we leave the number at 5."

Evidence is deduced that the experimental area was used the previous year for an experiment of 4 blocks of 12 plots each, of which 3 plots exercised a good residual effect. The bottom row of plots was perhaps occupied by a footpath previously. Finally a warning is given that it is much more difficult to correct results of an experiment that is carried out on the site of a previous experiment. If this cannot be avoided, attention should be paid to its possible effect on the new experiment.

It is concluded that, on the basis of an actual experiment, a sufficiently accurate estimate of the degrees of freedom used in applying a graphical correction can be obtained, and that in that case the advantage of the graphical correction over a "Fisher correction" is as great as that of a "Fisher correction" over no correction; and that by the graphical correction faults in experimental layout can be eliminated. It is also pointed out that Fisher does not make efficient use of degrees of freedom, because quantities that are closely related—*e.g.*, rows and columns—are considered as independent.

192. Note on Simple Field Experimentation. By S. H. Evelyn. (Res. Div. Dept. of Agric. and For., Sudan Govt., *Memo No.* 6.) Suggests methods for the layout of replicated and randomised plots. Advice is given on the choice of site and the size and shape of subplots, cultural operations and the avoidance of edge effects.

193. Seed Pellets Sown by Aeroplane. (*Ind. Fmg.*, viii, 8, 1947, p. 400.) Not long ago aeroplanes sprayed millions of pellets on bare western range lands in the United States in an effort to reclaim the area for agriculture. Each pellet contained grass seed, fertilizer, treatment to prevent mould, and chemicals to protect the seed from insects and animals. The bulk of each pellet was formed of soil taken from the area where the planting was later made. Although seeding from aeroplanes had been done before, this project combined all of the new resources of science to assure its success. During the planting season this year, hundreds of experiments in the new method of seed coating were undertaken, and the results were generally excellent. Among advantages reported were greater yields, cutting down of thinning ordinarily necessary with many crops, and significant savings in the amounts of seed used. The pelleting method has been used with sugar-beets, pumpkin, tomato, corn, cotton, alfalfa, spinach and grass seeds.

194. Studies in the Agronomy of Gaorani Cottons. I. Preparatory Tillage and Interseasonal Cultivations. By P. D. Gadkari and V. K. Joshi. (*Ind. J. of Agric. Sci.*, xvi, 6, 1946, p. 504. Received 1948.) Cultivation experiments with Gaorani 6 cotton conducted at the Cotton Research Station, Nanded, during the period 1941-45 showed that: 1. Variations in frequencies and timings of *bakharings* and ploughings in preparatory tillage for cotton grown after *kharif* or *rabi jowar* or after groundnut did not improve yield of Gaorani 6. 2. A weeded crop gave a significantly higher yield than the unweeded one. One weeding should be normally enough, since additional weeding did not offer any extra benefit except in years of abnormally late rains. 3. *Khurpi* is the most suitable implement for intercultivation operations in Marhatwada.

195. Note on the Trial of Cambodia Cotton at the Agricultural Research Station, Aduturai, Tanjore Delta. By M. Anandan. See Abstract No. 129.

196. Studies in the Quality of Hirsutum Cottons Grown Under Irrigation on the Arbhavi Farm. By H. R. Nayak. See Abstract No. 130.

197. Irrigation. By K. J. MacKenzie. (*Rhod. Agric. J.*, xlv, 4, 1948, p. 312.) The following methods of irrigation are described: terracing; free flooding; basin method; cross flooding by means of field furrows between contours; row irrigation; bench and roll for orchards. The advantages and disadvantages of the various methods are noted, and general advice is given regarding layouts.

198. Ammonium Trichloroacetate: Use as Herbicide; Effect on Cotton. By T. C. Ryker. (*Sugar J.*, 10, 11, 1948, p. 16. From *Summ. Curr. Lit.*, xxviii, 24, 1948, p. 587.) Johnson and Bermuda grasses were successfully controlled in preliminary experiments by application of 218 lb. or more of ammonium trichloroacetate per acre in 400 gallons of water. Cotton plants were injured to some extent

by this compound, although it showed promise as a selective herbicide for narrow-leaf plants in cotton fields.

COTTONSEED AND COTTONSEED PRODUCTS

199. COTTONSEED OIL AND CAKE. By M. Afzal. (*Ind. Cott. Grwg. Rev.*, ii, **4**, 1948, p. 167.) The author gives some general information about cottonseed oil, reviewing the development of the industry in the United States and giving tables showing world production of cottonseed, the chemical analysis of the content of American and West Punjab cottonseed, and the feeding value of cottonseed and cottonseed cake. In the sub-continent of India the cottonseed crushing industry is still very young, and in the Western Punjab, where it is most developed, there were only 26 crushing mills in 1946.

MACHINERY

200. OKLAHOMA: FARMERS' EXPERIENCES WITH COTTON STRIPPERS. By J. C. Campbell. (*Okla. Agric. Exp. Sta. Bull. B*-324, 1948.) This Bulletin contains the report on a survey made for the purpose of gathering information useful to research workers in developing varieties, methods and machinery for cotton mechanization. The most serious limitation on the use of strippers appears to be the presence of leaves and green bolls. The results from chemical defoliation have been irregular; secondary growth after defoliation sometimes causes trouble, and green bolls are still a problem. It was established, however, that where cotton was too thin to harvest by hand at customary rates, factory built strippers wasted much less cotton than sleds, and that the grades from stripped cotton were considerably higher than from sledded cotton. Stripper operators agreed that the following characteristics were especially desirable in cotton to be harvested with strippers: (1) high degree of storm resistance; (2) short limbs; (3) medium size stalks; (4) uniform maturity of bolls; (5) easy separation of bolls from stalks; (6) medium high fruiting; and (7) light foliage.

PESTS, DISEASES, AND INJURIES, AND THEIR CONTROL

201. COTTON INSECT INVESTIGATIONS. By F. F. Bondy and C. F. Rainwater. (*58th Rep. S. Carolina Exp. Sta.*, 1944-45, p. 101. From *Rev. App. Ent.*, xxxvi, Ser. A, **11**, 1948, p. 370.) Field experiments over several years on the control of the boll weevil (*Anthonomus grandis*, Boh.) on cotton in South Carolina have shown that mopping at the pre-square stage with a mixture of calcium arsenate, molasses and water (1 : 1 : 1) reduces the early weevil population and effects some degree of control, but as the time for effective mopping is usually over before the hibernating weevils have completed their emergence, this method has not proved satisfactory in years of heavy weevil damage. Dusting with calcium arsenate has resulted in far greater increases in yield than mopping, and mopping followed by dusting has resulted in only slightly greater yields than dusting alone. Unlike calcium-arsenate dust, mopping has not caused a noticeable increase in the cotton Aphid (*Aphis gossypii*, Glov.). The addition of 1 per cent. nicotine to calcium arsenate or of 0·75 per cent. rotenone to calcium arsenate or basic copper arsenate has prevented *A. gossypii* from developing to injurious numbers, and given more satisfactory results than higher dosages of nicotine applied after heavy populations have been built up. Basic copper arsenate has proved a fairly effective substitute for calcium arsenate against *Anthonomus*, but DDT, tested in 1945, was not effective against either the weevil or the Aphid when used as a 10 per cent. dust in pyrophyllite, a 5 per cent. dust with calcium arsenate or basic copper arsenate or with mixtures of either of these materials with rotenone or nicotine, or in sprays containing 2 or 4 lb. 40 per cent. water-dispersible DDT per 50 U.S. gallons water.

Observations made by means of hibernation cages, by collecting hibernating weevils from surface trash and by means of trap crops have shown that temperature

is the most important factor in determining the survival of *A. grandis* in winter, but humidity has the greatest influence on emergence in spring. Emergence is late in dry springs, regardless of temperature, and early, wet springs seem to extend the period of emergence, although larger percentages of the weevils emerge early. The percentage of total emergence between June 15 and 30 has ranged from 42 in 1943 to 19 in 1945, with an average of 38 for the period 1938-45. The emergence of more than 33 per cent. of the weevils after June 15, when the early squares are large enough for oviposition, assures the development of damaging infestations in favourable seasons and largely explains why pre-square poisoning does not give effective control.

When the oxides of various metals were added to calcium arsenate to prevent injury to plants growing in light, sandy soil containing it, 5 per cent. by weight of the oxides of iron, copper, lead and zinc showed corrective tendencies, which were more pronounced in the second year following heavy applications (500 lb. per acre) of the mixture than in the first year. The oxides of magnesium and manganese had little or no corrective effect.

202. Boll Weevil and Cotton Aphid: Control by Benzene Hexachloride. By E. W. Dunnam and S. L. Calhoun. (*J. Econ. Entom.*, **41**, 1948, p. 22. From *Summ Curr. Lit.*, xxviii, **18**, 1948, p. 409.) Results of experiments to compare the effectiveness of benzene hexachloride with that of calcium arsenate and nicotine for the control of the boll weevil and cotton aphid are reported. At 5 per cent. of the γ-isomeride and equal rate of application per acre at 4- and 5-day intervals, benzene hexachloride was as effective on weevils as calcium arsenate. Intervals of 7 days were beyond the range of effectiveness. Cotton aphids are controlled with a much lower γ-isomeride content than boll weevils. Differences in compatibility of calcium arsenate-benzene hexachloride mixtures were noted; undue exposure to moisture during or after mixing may have been responsible for these differences.

203. Queensland: Cotton Pests. (*Ann. Rpt. Dpt. Agr. and Stock.*, 1947-48.) Insect pests have not been a limiting factor to the cotton crop during the season. One minor outbreak of corn-ear worm (*Heliothis armigera*) occurred during the summer, but the infestation was insufficient to give worth-while results from the experimental work at Biloela Regional Experimental Station. It is already apparent, however, that DDT sprays will give more effective control of the pest than lead arsenate. The emulsions can be used up to concentrations of 0·3 per cent. without difficulty and the dispersible powders at even higher concentrations. Some trouble has been encountered from aphids (*Aphis gossypii*) on cotton treated with both dispersible powder and emulsion sprays. As in the case of lead arsenate, though to a lesser extent, an increase in the aphid population can be expected when DDT is used at these relatively high strengths. The yellow peach moth attacked cotton, particularly in coastal districts. It was the primary boll-pest during the summer period, a most unusual phenomenon.

204. Cotton Insects: Control by Benzene Hexachloride Mixtures. By R. C. Gaines and M. T. Young. (*J. Econ. Entom.*, **41**, 1948, p. 19. From *Summ Curr. Lit.*, xxviii, **18**, 1948, p. 409.) Benzene hexachloride was mixed with pyrophyllite or calcium arsenate and tested as a dust in cages and in field plots against boll weevils, tarnished plant bugs, cotton aphids, and cotton leaf worms. Sulphur and calcium arsenate, each, were tested in comparison. Mixtures of benzene hexachloride and calcium arsenate gave no better weevil control than calcium arsenate alone. At 1·44 per cent. of the γ-isomeride, benzene hexachloride gave a fairly satisfactory control of adult plant bugs. Four ounces or more of γ-isomeride per acre were required for satisfactory control of heavy infestations of aphids. In laboratory tests, a fumigating action of benzene hexachloride was demonstrated. Red spiders were more numerous on cotton dusted several times with benzene hexachloride than on cotton dusted with other insecticides or on untreated cotton. Benzene hexachloride killed many beneficial insects on cotton.

205. Behaviour of the Desert Locust (*Schistocerca gregaria*, Forskal) in Kenya in Relation to Aircraft Spraying. By D. L. Gunn, *et al.* (Anti-Locust Res.

Centre, *Bull.* 3, 1948.) In their account of aircraft dusting experiments against settled Desert Locusts, Kennedy, Playford and Bect (1944) pointed out that the planning of such aircraft operations required a greater knowledge of locust behaviour than then existed. In particular, one must be able to predict the time available for an attack before the departure of a swarm. This report describes an attempt to find an adequate basis for such predictions.

206. LOCUST CONTROL BY AIRCRAFT IN TANGANYIKA. By D. L. Gunn, *et al.* (Anti-Locust Res. Cent., Lond., 1948.) An experimental aircraft spraying campaign against adult Red Locusts was suggested at a Conference of the International Red Locust Control Organization at Lusaka in late June, 1947. The circumstances in the Rukwa Valley outbreak area seemed likely to be suitable for such a campaign, which was accordingly organized and completed by early November, 1947. Conditions turned out to be unfavourable at Tumba in the North Rukwa and favourable at Milepa in the Central Rukwa. The finding and delimitation of swarms in the latter area were much less difficult than in most types of country; wind direction was satisfactorily predictable; and towards the end of the period, locust behaviour was quite unusually favourable, for the swarms became virtually stationary. Altogether 2,100 gallons of 2 per cent. gamma benzene hexachloride (BHC) solution and 3,920 gallons of 20 per cent. dinitro-*ortho*-cresol (DNOC) solution were used. Omitting certain experiments, 1,755 gallons of the BHC were sprayed on 296 acres and 3,700 gallons of the DNOC on 3,335 acres. The BHC was slow in killing the locusts and it was subsequently found to have been sprayed from too low an altitude to give a uniform enough application. Consequently a satisfactory estimate of its efficacy cannot be given, though it is undoubtedly less toxic and more costly than DNOC for use against locusts.

The technique of spraying the DNOC solution and the solution itself were highly satisfactory, giving complete mortalities at slightly over 1 gallon per acre. The costing of aircraft spraying operations is discussed in relation to both anti-locust strategy and alternative methods of suppressing an outbreak. Aircraft operations could be carried out at a cost per acre little greater than that of the insecticide, if they were sufficiently intensive and prolonged; but the total cost would then be considerable. It is suggested that the best use could be made of aircraft if they could destroy swarms of locusts in flight, and that roosting locusts could be attacked more economically by machinery mounted on suitable trucks.

207. HELICOPTER SPRAYING IN THE SUDAN. (*Crown Colonist*, Dec., 1948, p. 707.) A Westland Sikorsky helicopter has been used to spray 90 acres of young cotton plants at Turabi, on the fringe of the Gezira, with insecticide to counter the ravages of the jassid insect. The helicopter, believed to be the first to be used in Africa, was introduced when it was found that spraying from tractors was impracticable during irrigation.

208. ANTRYCIDE. (Col. Off. Inf. Dept., Dec., 1948.) The Colonial Office have announced the discovery of Antrycide, a new drug which will cure trypanosomiasis in cattle, and thus render safe for cattle rearing large areas of Africa hitherto undeveloped by reason of this disease. The period of immunity following treatment has not yet been stabilized. Experiments are being carried out by Government Veterinary Departments, and it is unlikely that the drug will be available for commercial use for some considerable time.

209. INTERNATIONAL SCIENTIFIC COMMITTEE FOR TRYPANOSOMIASIS RESEARCH. (Col. Off. Inf. Dept., Feb., 1949.) In his opening speech Mr. A. Creech Jones, the Secretary of State for the Colonies, reported the establishment of a Standing Research Committee, the purpose of which was to give members the opportunity of discussing papers on the various aspects of research and to keep members informed of the relationship of new discoveries to the whole of the trypanosomiasis problem in Africa. Mr. Creech Jones stressed the point that it was not intended to make the Committee a Government organization.

210. CONTRIBUTION À L'ÉTUDE DES PARASITES DES VÉGÉTAUX DU CONGO BELGE. By R. L. Steyaert. (*Bull. Soc. Roy. Bot. Belg.*, lxxx, 1-2, 1948, p. 11.) A compre-

hensive and annotated list of fungi parasitic on various hosts in the Belgian Congo. The collection includes 48 species not previously recorded in that area, and describes 7 entirely new species. Mention is made of the following: *Entomophthora pyralidarum* on *Dysdercus superstitiosus; Sclerospora sorghi* on *Sorghum arundinaceum; Nematospora phaseoli* on *Soja hispida; Spermophthora gossypii, Alternaria macrospora, Asochyta gossypii, Macrophomina phaseoli, Fusarium vasinfectum, Phyllosticta gossypina*, and *Myrothecium roridum* on cotton.

211. ASCOCHYTA BLIGHT OF COTTON. By M. M. Wallace. (*E. Afr. Agric. J.*, xiv, 1, 1948, p. 10.) During the past two years outbreaks of Ascochyta blight, caused by the fungus *Ascochyta gossypii* Syd., have been reported on cotton crops in the Lubaga and Ukiriguru districts of the Lake Province, Tanganyika. Ascochyta blight of cotton was first recorded in Kashmir in 1908. In 1915 it was reported in Arkansas, and has since spread through the cotton belt of the United States. It can be deduced from the various accounts in the literature that the fungus is potentially serious, but that it is often present in a comparatively innocuous form. When conditions are particularly favourable for the development of the parasite, as in periods of cool wet weather, it becomes actively parasitic—stems and petioles are attacked, large elongated lesions being formed, and the plants may be killed. This is the " stem lesion " phase, or the typical Ascochyta blight. The blight can, however, attack all above-ground parts of the cotton plant with the exception of the flowers.

The disease in its early stages can be confused with Blackarm (*Xanthomonas malvacearum*). The initial stem discoloration and the cracking are common to both diseases, but the development of the paler coloured central areas of the lesions bearing numerous black pycnidia serves to distinguish the Ascochyta blight. The control measures include a close watch for the parasite throughout the growing season, especially during and after wet weather, and the destruction of all infected plants. All ground should be carefully cleared of dead cotton trash which should be burned. Crop rotation is also suggested as a possible means of eliminating the disease.

212. COTTON: BACTERIAL BLIGHT. By R. Weindling. (*U.S. Dept. Agric. Tech. Bull.* 956, 1948.) Bacterial blight of cotton, caused by *Xanthomonas malvacearum*, has been studied under conditions of artificial inoculation. The results are reported and discussed under the headings: Infection and disease reaction of individual leaves; artificially induced epidemics in relation to varietal resistance and epidemiology; and miscellaneous studies. Two forms of the disease have been distinguished in this experimental work—mild and epiphytotic. It is shown that the influence of environmental and other factors on the development of the disease varies according to the phase of the disease, the method of inoculation, and the type of infection. Leaf spot served as the principal indicator of relative resistance in grading inoculated field plants. Experimental data are presented in an appendix of 25 tables.

213. THE GENETICS OF BLACKARM RESISTANCE. VII. *Gossypium arboreum* L. By R. L. Knight. (*J. of Genet.*, 49, 2, 1948, p. 109.) The immunity of Multani cotton (a variety of *Gossypium arboreum* race *bengalense*) to *Bact. malvacearum* is shown to depend on a major gene, B_4, accompanied by a strong complex of minor genes. No such strong complex has ever been found in cottons of immediate New World origin. From this and other data, it is argued that the cottons of India have undergone a strong selection pressure from *Bact. malvacearum* for longer than the cottons of the New World, and it is suggested that this disease originated in the Old World—probably India.

214. FUNGICIDES: MICRO-ASSAYS. By N. C. Abiusso. (*Publ. Misc. Minist. Agric.*, Buenos Aires, 1948, Ser. A, 4, 39. From *Rev. App. Mycol.*, 27, 1948, p. 434.) The first part of this study is concerned with the biological factors affecting spore germination by the slide-germination (moist chamber) method, using a number of fungi, including *Fusarium culmorum* from hemp, and *F. vasinfectum* from cotton. Conditions for spore germination requiring standardization are pointed out. In the second part, laboratory biological tests of a number of compounds are reported. The

following are among the results quoted: the germination of *F. vasinfectum* was inhibited by cetylpyridine chloride at 1 in 200,000; mercury o-chlorophenolate suppressed the germination of *F. culmorum* at 1 in 10,000,000; and *F. vasinfectum* succumbed to mercury alkyloxychloride at 1 in 200,000. No germination of *F. vasinfectum* occurred in the presence of hydroxymercurinitrophenol at 1 in 100,000 or 1 in 200,000 in two separate tests.

215. CLASSIFICATION AND IDENTIFICATION IN *Fusarium.* By W. C. Snyder and H. N. Hansen. (*Phytopathology,* **38,** 1948, p. 23. From *Pla. Bre. Abs.*, xviii, **3,** 1948, p. 487.) The classification of the genus *Fusarium* is discussed. A system of classification in which only a few species are recognized, on the basis of morphology and pathogenicity, is indicated by named forms, and numbered races within the form is advocated. This system has been found in practice to facilitate identification.

216. COTTON SEEDLINGS: OCCURRENCE OF *Fusarium* "TAKE-ALL" DISEASE IN KOREA. By S. Koba. (*Ann. Phytopath. Soc. Japan,* **11,** 1942, p. 186. From Summ. Curr. Lit., xxviii, **20,** 1948, p. 481.) In Western Korea, four species of *Fusarium* which cause the "take-all" disease of cotton seedlings are found. The disease is favoured by low temperature (12°C.) and by the heavy rain which almost saturates the soil.

217. SOIL TREATMENT CONTROL OF *Fusarium* WILT AND NEMATODES OF COTTON. By A. L. Smith. *Phytopathology,* xxxviii, **7,** 1948, p. 573. From *Rev. App. Mycol.,* xxviii, **1,** 1949, p. 15.) Practically complete control of cotton wilt and nematodes was obtained in two years' experiments in Georgia with dowfume W-10 (10 per cent. ethylene bromide by volume) applied at the rate of 30 to 37 gals. per acre. The acre yield of Coker 4 in 1-7 cotton was increased from 367 to 1,067 lb. and of Deltapine 14 from 64 to 904 lb. lint in a test on Catawba fine sandy loam (deep phase) in 1947, representing increases from treatment of 191 and 1,312 per cent., respectively. In the same varieties the percentage of wilt was reduced from 52·7 to 1·8 and from 96·8 to 3·2. Coker 4 in 1-7 is on about the same level of resistance as most commercial varieties, while Deltapine is rather susceptible. A second test in 1947, using dowfume at the rate of 12½ gals. per acre in the rows, was slightly less effective against both wilt and nematodes; the highly susceptible Hurley's Rowden was not adequately protected, but Miller 610, Dixie Triumph 366, Cook 142, and Coker 4 in 1-7, with varying degrees of wilt resistance, gave yields comparable to those obtained from heavier dosages.

218. WILT RESISTANCE IN EMPIRE COTTON. By A. L. Smith and W. W. Ballard. (*44th Proc. Ass. Sth. Agric. Wkrs. Miss.*, 1947, p. 187. From *Pla. Bre. Abs.*, xviii, **4,** 1948, p. 769.) Wilt-resistant lines of Empire have been selected in Alabama. The wide range in reaction to this disease shown by the selfed progenies indicates the heterozygosity of the original plant from which Empire was developed, and suggests the probable origin of this variety from a cross between Stoneville 2 and a wilt-resistant cotton.

219. *Xanthomonas malvacearum* DOWSON ON EXOTIC COTTONS IN INDIA. By M. K. Patel and Y. S. Kulkarni. (*Curr. Sci.*, xvii, **8,** 1948, p. 243. From *Rev. App. Myc.*, xxviii, **1,** 1949, p. 15.) *Xanthomonas malvacearum* has now been isolated in India for the first time from leaves of exotic cotton varieties received from various parts of Bomaby Province. A description of the organism and the symptoms of the disease on Indian cottons is given. Exotic cottons belonging to *Gossypium barbadense, G. purpurascens, G. hirsutum,* and *G. thurberi* are susceptible, whereas some Indian cottons of the *G. herbaceum* and *G. arboreum* groups are highly resistant. Further studies are in progress.

220. AMELIORATION OF BAD OPENING OF BOLLS IN AMERICAN COTTONS IN SIND. By R. H. Dastur. (*Ind. Cott. Grwg. Rev.*, ii, **3,** 1948, p. 110.) Bad opening of bolls (*Tirak*) in American cottons has been found to be of common occurrence in different cotton growing parts of Sind, and extensive investigations have shown that the disease was primarily caused by certain soil conditions which were widely and irregularly distributed in the cotton soils of Sind. Symptoms of the disease were

exhibited by the crop when it grew on very light sandy soils deficient in nitrogen, and where the subsoil at a depth of 2 or 3 feet contained abnormal amounts of sodium salts. Experiments in the sowing date were carried out, and these showed conclusively that the late-sown crops did not suffer from *tirak*. Closer spacing is necessary to counteract the loss in yield caused by reduction in the number of bolls per plant consequent upon the late sowing. Tables are given showing the optimum dates for planting and the recommended spacing between rows and between plants, and seed rates in lb. per acre for every fortnight in the sowing period for each cotton-growing tract.

221. Cotton Root Rot: Control by Sweetclover in Rotation. By E. W. Lyle, *et al.* (Texas Agric. Exp. Sta., *Bull.* 699, 1948.) This bulletin presents the results of a 5-year study at the Blackland Experiment Station on the effectiveness of winter and winter-summer crops of *Melilotus indica* (indica) and *Melilotus alba* v. *annua* (hubam) in rotation with cotton for the control of root rot. When sweetclovers were used as green-manure crops (plowed under in early spring) and followed by cotton the same year, cotton root rot was delayed and decreased and increases in yield were found in most cases. Delay and marked reduction in cotton root rot and the highest yield of cotton were found in the plots in which hubam had been grown to maturity the previous year. Outstanding yield increases in cotton were obtained during the first 2 years following the rotation with mature hubam and there was also an apparent increase in the third-year cotton after hubam. The degree of root-rot control, as shown by the increased yield of cotton in plots following mature hubam the previous year, is proportional to the reduction in number of cotton plants killed early in the season by root rot. Late-season root rot has less effect on yield. The beneficial effects of the hubam in rotation appeared to diminish with successive plantings of cotton, making the plowing under of the mature hubam crop necessary about every third or fourth year for the best results.

GENERAL BOTANY, BREEDING, ETC.

222. The Session of the Lenin Academy of Agricultural Sciences on the Position of Biological Science. (*Pla Bre. Abs.*, xviii, 4, 1948, p. 642.) In this abstract the Central Bureau of Plant Breeding and Genetics gives a summary of papers submitted at the Conference held at the Lenin Academy in July/August, 1948. As a result of this Conference a decree was issued from the Præsidium of the Academy of Sciences on August 27, 1948, which contains the following resolutions:

(1) L. A. Orbeli shall be released from his duties as Academician-Secretary of the Division of Biological Sciences. Academician A. I. Oparin will take over his duties until a new Academician-Secretary is elected by the full assembly. T. D. Lysenko shall become a member of the Bureau of the Division of biological science.

(2) Smaljgauzen is released from his duties as Director of the Severcov Institute of Evolutionary Morphology.

(3) The Cytogenetical Laboratory of Cytology, Histology and Embryology, headed by N. P. Dubinin, shall be abolished as unscientific and useless. The Laboratory of Botanical Cytology at the same institute shall be closed down on the grounds that it has followed the same incorrect and unscientific line. The Phenogenetic Laboratory shall be abolished at the Severcov Institute of Evolutionary Morphology.

(4) The Bureau of the Division of Biological Sciences shall be charged with the preparation of plans for scientific research work for the years 1948-50. In this the Bureau shall be guided by Micurin's teaching, and shall adjust the scientific research work of the biological institutes to the needs of national economy.

(5) The Editorial Council and the Division of Biological Sciences shall be charged with the preparation, during the period 1948-49, of a publication of Micurin's scientific biography in the series *Klassiki Nauki* (*Scientific Classics*).

(6) The composition of Scientists' Councils at biological institutes and editorial

boards of biological publications shall be checked, with the object of removing from them the partisans of Morgano-Weismannite genetics and of replacing them by supporters of progressive Micurinite biology.

(7) The Division of History and Philosophy shall be charged with inclusion in its programme of popularization of the achievements of Micurinism and of critical exposure of the pseudo-scientific Morgano-Weismannite tendency.

(8) The Bureau of the Division of Biological Sciences shall be charged with the revision of the working programmes and the composition of the scientific personnel at biological institutes. The Bureau shall produce within a month a project for the reorganization of the Severcov Institute of Evolutionary Morphology, and of the Institute of Cytology, Histology and Embryology.

(9) The Editorial Council shall revise, within a month, the existing plans for publication with the object of securing the publication of works on Micurinite biology.

(10) The Division of Biological Sciences shall call in October, 1948, an extensive session devoted to the problem of promoting Micurinism. Every branch of the Academy shall participate.

(11) The Bureau of the Division of Biological Sciences shall revise the syllabuses at biological institutes, bearing in mind the interests of Micurinism.

(12) A full report of the extended conference of the Academy's Præsidium shall be published in the next issue of *Vestnik Akademii Nauk* (*Proceedings of the Academy of Sciences*).

The text of the resolution offers explanation of some of the measures taken and some additional information. At a number of Academy institutes formal genetics has not been combated with sufficient vigour. For this the Præsidium of the Academy takes the blame. The Bureau of the Division of Biological Sciences and its head, L. A. Orbeli, have failed to give a correct orientation to the work of the biologists of the Academy. The report by Lysenko, which has been approved by the Central Committee of the All-Union Communist Party, has exposed the scientific inconsistency of the reactionary idealist theories of the followers of Weismannism, Smaljgauzen, Dubinin, Zebrak, Navasin and others.

223. Plant Cytology and General Cytology. By P. Dangeard. (Paul Lechevalier, Paris, 1947. Price Fs. 1,250. From *Pla. Bre. Abs.*, xviii, 3, 1948, p. 598.) This treatise deals with many of the different aspects of cytology, and the author has not only explained modern concepts and hypotheses, but has also traced their historical development. He has dealt chiefly, but not exclusively, with the plant cell, which is treated, not simply as a static object as it appears in fixed and stained preparations under the microscope, but as a living entity undergoing constant change. No specialized knowledge on the part of the reader is assumed, the book being intended to serve as an introduction to cytology. It begins with a simple and generalized account of cell structure. The first chapter deals with protoplasm, its composition, structure and behaviour, and the second and third chapters with chondriosomes and plastids. About half the book is devoted to the nucleus and especially the chromosomes and their behaviour during nuclear division in both typical and atypical cells. Descriptions are included of the nuclei of the lower organisms. There is a chapter on cytogenetics in which mutations are discussed, and another on the sex chromosomes and problems connected with them. The concluding chapters pertain to the vacuome of cells, the Golgi apparatus, various inclusions of the cytoplasm, and the plant cell wall. The bibliographies at the ends of the chapters include English, French and German literature published up to 1946.

224. Asynapsis in the Progeny of a Monosomic Plant of Cotton. By M. S. Brown. (*Genetics*, 33, 1948, p. 97. From *Pla. Bre. Abs.*, xviii, 4, 1948, p. 767.) The progeny of a monosomic plant with quadrivalents included a number of sterile plants which were found to have 52 univalents at meiotic metaphase, multipolar spindles at anaphase and numerous microspores in the tetrad stage. The monosomic plant included the variety Coker 100 (*Gossypium hirsutum*) in its parentage. It is

thought that these sterile plants may have received the gene for asynapsis, known to occur in Coker 100, in triplicate or quadruplicate as a result of irregularities in chromosome segregation.

225. THE TAXONOMIC DISTRIBUTION OF THE COMPLEMENTARY LETHAL "CRUMPLING" GENES IN ASIATIC COTTONS. By R. A. Silow. (*Ind. J. Genet. Pl. Breed.*, 6, 1946, p. 1. From *Pla. Bre. Abs.*, xviii, 4, 1948, p. 767.) The semi-lethal or lethal abnormality known as "crumpled" occurs in *Gossypium arboreum* and *G. herbaceum*, and depends upon two complementary genes designated CP_a and Cp_b. A table is given summarizing the taxonomic distribution of the genes Cp_a, cp_a, Cp_b, cp_b, in the two species, based upon a survey of the Trinidad Type Collection, and incorporating data from 31 strains tested by Hutchinson in 1932 and 4 studied later by Nath and Govande. The evolutionary significance of the lethal mechanism is discussed; the complementary genes for "crumpled" are considered to have played only a subsidiary rôle in the evolution of *G. arboreum* and *G. herbaceum*. Stephens has concluded that the hypothesis of complementary alleles at a single locus postulated by him for the character of "corky" (cf. *Emp. Cott. Grwg. Rev.*, xxiii, 1, 1946, p. 74) is also applicable to the character of "crumpled." The present author suggests future lines of investigating whether "crumpled" is due to complementary alleles at a single locus or complementary genes at single loci. Linkage studies in diploid Old World cottons involving easily scored characters are recommended.

226. POLLEN VIABILITY IN COTTON. By R. Balasubrahmanyan. (*Ind. Cott. Grwg. Rev.*, ii, 3, 1948, p. 145.) In breeding programmes involving intensive hybridization between geographically isolated races or species, the periodicity of flowering of the two parents entering the cross determine, to a very large extent, the successful execution of several items according to the plan. It has been the common experience at Coimbatore and Palur that African, American and Russian *hirsutum* varieties were invariably earlier than acclimatized Indian types in attaining the flowering phase, while most of the *barbadense* collections were inordinately late, coming to flower two months after the local American varieties. Consequently, flower buds from the chosen parents were not available on the same day for crossing. Various methods like adjustments in the time of planting, flower pruning in early varieties and close spacing to quicken bud formation were tried without success. During these investigations it was also found that environment of particular localities favoured the growth of some types, and by adjustments in planting dates or through retention of the crop in the off-season they could be induced to flower profusely just when the local types were in full bloom at other centres. It was thought that if the pollen could stand transport over long distances and days the first hurdle in the hybridization would be got over. Preliminary experiments were carried out last season when immature flower buds due to open a couple of days hence were sent by post, packed in cellophane rolls, over a distance of 275 miles from Coimbatore to Palur involving a time interval of 44 hours since their removal from the parent plant. The pollen from these transported buds was dusted on to the emasculated normal flowers immediately on receipt between 11 a.m. and 3 p.m. The boll setting was 43 per cent. of the total number of crosses made and the contents of such developed bolls were quite normal.

227. DISCONTINUITY OF HAIR PRODUCTION ON COTTON OVULES SOON AFTER FLOWERING. By G. Seshadri Ayyangar. (*Ind. Cott. Grwg. Rev.*, ii, 3, 1948, p. 119.) The counts of hairs borne on the median sections of ovules point out that no fresh hairs are added on between 14 and 56 hours after pollination. It is also observed that fertilization has no effect on the production of hairs. This is in complete harmony with the observations of Balls (1915). The cessation of hair production is, however, suggestive of the possibility that the processes immediately precedent to, and following, fertilization may have an inhibitory effect on the stimulus of hair production. With regard to the influence of the position of ovules on the number of sprouting hairs, it is seen that the ovules which are nearest to the pedicel bear more hairs than the ovules placed above them, and that the first ovules which are

nearest to the stigmatic end have the least number of hairs. This finding is in agreement with the conclusions of Iyengar (1941) on the number of hairs borne on mature seeds, and of Ramanatha Iyer (1929), who found that the topmost seed in the boll has the lowest, and the bottom-most seed the highest lint weights. This indicates that the number of hairs produced at the time of flower-opening is a mathematical function of the final number of hairs borne on each seed. It can also be deduced from the relationship between the position of seeds and the number of hairs produced on them, that the proximity of food supply has a direct influence on the number of sprouting hairs. This is also supported by the observation that on a single seed the density of hairs near the chalazal end, which is nearest to the centre of food supply, is greatest.

228. Some Observations on Stomata found on Cotton Ovules. By G. S. Ayyangar. (*Ind. Cott. Grwg. Rev.*, ii, 4, 1948, p. 187.) The studies show that the stomata on the integuments of cotton ovules are produced at the chalazal end two days prior to the flowering, and that their modes of later distribution follow that of epidermal hairs. They show variations in size and depth of the air-chambers, in the size of guard cells, in the production and transformation of subsidiary cells and in the mode of blocking air-chambers below the stomata. Stomata are found to be formed up to the twenty-fourth day after flower opening, and to be functioning in spite of their being located inside the boll. They seem to be more concerned with respiration than transpiration.

229. Unfertilized Seeds of Cotton. By P. C. Wang. (*Nung Pao*, 8, 1943, p. 17. From *Pla. Bre. Abs.*, xviii, 3, 1948, p. 539.) An investigation was carried out to study the genetic and environmental factors causing the formation of infertile seeds of cotton. Such seeds are found in all varieties of cotton. They are less than 1 mm. in diameter, with no or very short hair. Fifteen varieties of both native and foreign cotton, producing varying yields, were studied for two years. The results are summarized as follows—(1) On the average the Chinese cottons contain 10·18 per cent. infertile seed and the American varieties 17·98 per cent. Some varieties are constantly high and some are constantly low in the percentage of these seeds year after year. (2) Most of the infertile seeds are found in the basal portion of the boll, some in the middle and further still in the tip. (3) The percentage of infertile seeds is independent of nutrition and fertilizers. (4) The percentage of infertile seeds varies with season. It is higher in the early and the late flowers. (5) The percentage of infertile seeds is positively correlated with temperature and negatively with atmospheric humidity. Temperature is comparatively more important.

230. Effects of some Environmental Factors on the Seed and Lint of Cotton. By D. G. Sturkie. (*Bull. Ala. Agric. Exp. Sta.*, 263, 1947, p. 87. From *Pla. Bre. Abs.*, xviii, 4, 1948, p. 768.) A report is given of experiments, carried out by the Agricultural Experiment Station of the Alabama Polytechnic Institute, to determine the effect of various environmental factors upon the properties of the seed and lint of cotton. The following experiments are reported—(1) a study under controlled conditions to estimate the effect of variables of soil moisture, soil type, preparation of soil, fertilizers and organic matter upon the seed and lint properties of a pure line strain of Mexican Big Boll; (2) an experiment to study the response of Mexican Big Boll, Stoneville 5A, Clevewilt strain 5 and Cook 1006 to different conditions of soil moisture; and (3) a test of the effect upon the properties of several commercial cottons under different conditions of fertilization, preparation of soil, location and picking date.

231. The Organic Acid Content of Various Samples of Raw Cotton Fibre in Relation to Ash Alkalinity and Leaching by Rain. By E. R. McCall *et al.* (*Science*, 108, 1948, p. 360. From *Text. Tech. Dig.*, v, 12, 1948, p. 730.) Citric acid, λ-malic acid, and total organic acids were determined after fuming the samples with HCl and extracting with ether by procedures described in the literature. Pectic acid, ash, and alkalinity were determined by other methods. The *p*H of aqueous extracts of cotton was measured with the glass electrode. A correlation was found between total organic acids (including pectic) and the alkalinity of the ash.

The organic acids occur in the fibre as salts. Exposure to rain was found to decrease both the amounts of the organic acids and the alkalinity of the ash, but to increase the pH of the water extract. An unpublished colorimetric method for the determination of small amounts of pectic acid is mentioned but not described.

232. New Variety of Cotton—Mysore-American V. See Abstract No. 128.

FIBRES, YARNS, SPINNING, WEAVING, ETC.

233. X-ray Diffraction as a Tool in the Study of Textile Fibres. By J. F. Whitney. (*Frontier*, **11**, 1948, p. 18. From *Text. Tech. Digest*, v, **12**, 1948, p. 725.) The theory of X-ray diffraction analysis is reviewed and its application to the study of textile fibres is discussed. This type of analysis is particularly valuable in the study of fibre structure with reference to molecular orientation and crystalline character. Results of investigations have shown that, in any useful fibrous material, there exists a high degree of parallel orientation of long-chain molecules, upon which is superimposed a parallel crystalline aggregate. High orientation and crystallinity give good mechanical properties, although too high a degree of crystallinity is harmful to the dyeing characteristics of the finished material.

234. Cotton Fibre: X-ray Structure and Strength. By E. E. Berkley *et al.* (U.S. Dept. Agric., *Tech. Bull.*, **949**, 1948. From *Summ. Curr. Lit.*, xxviii, **21**, 1948, p. 511.) The X-ray method of determining cotton fibre properties in breeding work may be substituted for strength measurements where field damage has occurred, since in such samples it is an excellent means of (i) selecting good spinning cottons not readily identifiable as such by other fibre properties; (ii) differentiating unusual varieties or strains or environmental conditions where the usual strength/structure relations may not hold; and (iii) measuring relatively rapidly genetic differences affecting tensile strengths. The results of a study on the development of the X-ray method are described and discussed and presented in numerous diagrams and tables. There are 38 references to literature.

235. A New Method for the Determination of the Average Diameter of Textile Fibres, Filaments, etc. By Nazir Ahmad and R. L. N. Iyengar. (*Ind. J. Agric. Sci.*, xvii, **2**, 1947, p. 104.) Describes a new photoelectric method which has been developed for determining quickly and accurately the mean diameter of a large number of fibres.

236. Raw Cotton Fibre: Organic Acid Content. By E. R. McCall *et al.* (*Science*, **108**, 1948, p. 360. From *Summ. Curr. Lit.*, xxviii, **22**, 1948, p. 545.) A number of samples of raw cotton fibre of different varieties and grown in different places were analysed for organic acids, ash, and ash alkalinity. The data show that raw cotton fibre varies greatly in organic acid content; the greatest variation is in *l*-malic acid, citric acid and the unidentified portion of the organic acids showing less variation. The data also show correlation between the content of organic acids and the ash and ash alkalinity. Further data reveal that rain and other weathering factors have a profound effect, especially on the *l*-malic acid content.

237. Degree of Polymerization of Cellulose in Cotton Fibres. By L. E. Hessler *et al.* (*Text. Res. J.*, **18**, 1948, p. 628. From *Text. Tech. Dig.*, vi, **1**, 1949, p. 3.) The data reported in this article were obtained in order to determine the degree of polymerization of cellulose under a wide range of conditions, before and after treatments which may reduce the lengths of the molecules. Cotton fibres receive somewhat harsh treatments in the field before harvest, during processing, in laundering, and other treatments while in use. These studies were made in order to determine the magnitude of the variability in the degree of polymerization before treatment and the changes with simple treatments immediately after the bolls were opened and the fibres were exposed to light. The effects of chemical degradation as well as pre-harvest conditions in the field were studied. It was shown that the degree of polymerization of the cellulose in a given cotton fibre is dependent upon

many factors, among which are its development of cell-wall thickness, variety and location of growth, and degradation or damage.

238. VARIATIONS IN THE PROPERTIES OF THE COTTON FIBRE IN RELATION TO ITS POSITION ON THE SURFACE OF THE SEED, II. By Sri Nagabhushana. (*Ind. J. Agric. Sci.*, xvii, 6, 1947, p. 305.) While the differences in the fibre properties from region to region on the surface of the cotton seed have been investigated as regards (1) length, (2) weight, and (3) strength, by Koshal and Ahmad, the present tests deal with three more properties, (1) rigidity, (2) ribbon width, and (3) convolution. The materials are the same standard Indian cottons as were used in the previous investigation, viz., Nandyal 14, P.A. 4F, C.A. 9 (1928-29), C.A. 9 (1929-30), Gadag I (1928-29), Gadag I (1927-28), Verum 262 (Nagpur), and 1027 A.L.F., the slivers having been conjointly prepared. For all the eight samples fibres from the base and the apex were tested. In the case of Nandyal 14 only, fibres from the other regions, viz., right flank and left flank and the combed fibres, were also tested. The following conclusions have been drawn from the analysis of the results of this investigation:

(i) The fibres on the apical region of the seed possess higher fibre rigidity than those on the basal region, the difference between the mean values for the two regions varying from cotton to cotton and ranging between 39·0 per cent. for C.A. 9 (1929-30) and 183·4 per cent. for Gadag I (1927-28). The combed fibres have the lowest rigidity and the apical fibres the maximum, the difference between them being 131·4 per cent. The frequency distribution of fibre rigidity is asymmetrical not only for the base and the apex but also for the other regions as well. But while it is skew for the apical fibres, a J-shape tendency is observed for the basal fibres as also for a bulk sample. The rigidity modulus for the material of the fibre remains practically the same for the basal and the apical regions though differing from cotton to cotton.

(ii) The fibres in the apical region have practically the same ribbon width as those in the basal region for P.A. 4F, C.A. 9 and Verum 262, while for Nandyal 14, Gadag I and 1027 A.L.F. the apical fibres are significantly broader, the difference ranging from 9·0 per cent. to 12·5 per cent. from cotton to cotton. The combed fibres have the maximum ribbon width with the apical, the right and the left flanks, and the basal fibres following in the given order. The maximum difference, which is between the basal and the combed fibres, is 17·6 per cent. and it is significant, while the minimum difference between the two flanks is 1·1 per cent. and not significant, the difference between all the other regions, however, being significant. The frequency distribution of ribbon width is practically normal not only for the bulk but for each region also, unlike that of fibre rigidity for which the distributions in the different regions are dissimilar.

(iii) The difference in the number of convolutions per mm. between fibres from the apical and the basal regions varies from 14·1 per cent. for Gadag I (1928-29) to 43·3 per cent. for Nandyal 14, and is statistically significant in each case. With the exception of P.A. 4F, the convolutions in the apical fibres are more widely spaced than in the basal fibres. In P.A. 4F, however, the convolutions are more crowded in the apical fibres. Generally the basal fibres have 25-30 per cent. greater number of convolutions per fibre.

Judging from the ratio of ribbon width to convolutions as shown by Clegg, and the values of the product, length $\times$ $\sqrt{\text{hair rigidity}}$ as shown by Peirce, it is inferred that the apical fibres generally have a greater wall thickness.

The basal fibres have the highest number of convolutions both per fibre and per unit length. While the number of convolutions per mm. or their linear density is lowest in the fibres from the flanks and the apex, the total number of convolutions per fibre is lowest in the apical fibres, those from the flanks and the combed fibres coming next in order.

The form of distribution of convolutions hardly differs either from cotton to cotton or from region to region on the seed surface, being normal for the bulk sample as well as for the fibres from the different regions of the seed. These variations in

the fibre properties, not only within a given region on the seed surface, but also as between regions, are attributed to the time lag in the differentiation of neighbouring epidermal cells into lint hairs and the belated commencement of lint growth at the funicular end with a comparatively simultaneous cessation of lint length development, these again being the result of a relatively copious supply of nutrient matter at the base of the seed, particularly in the initial stages.

[*Cf.* Abstr. 129, Vol. X of this Review.]

239. COTTON: SPINNING CHARACTERISTICS. By J. F. Bogdan. (*Amer. Wool Cotton Reptr.*, **62**, 21, 1948, p. 53. From *Summ. Curr. Lit.*, xxviii, **22**, 1948, p. 544.) Strength and cohesion of the fibre and evenness of the yarn, as well as the relationships between count, strength and twist, are the factors needed to predict the yarn strength of cotton. The curve obtained by count-strength and twist relationships may be used to determine the spinning characteristics of cotton.

240. THE EFFECT OF MOISTURE CONTENT, FIELD EXPOSURE AND PROCESSING ON THE SPINNING VALUE OF ARIZONA UPLAND COTTON. By R. S. Hawkins and W. I. Thomas. (Agric. Exp. Sta., Arizona, *Tech. Bull.* 115, 1948.) Cotton produced in the irrigated sections of the south-west often spins differently from that grown under natural rainfall conditions. This has led to considerable controversy among producers, shippers, and manufacturers because of the price discriminations which sometimes result. For years it was thought that irrigation practice accounted for these spinning difficulties, but data obtained by the Arizona Agricultural Experiment Station show that seasonal climatic factors exert a greater influence on fibre properties than do ordinary variations in irrigation procedure. Studies in the moisture relationships of cotton have been made and among the conclusions drawn are the following. Spinning tests indicated that cotton containing more than 8 or 8·25 per cent. of moisture produced yarn of a lower index of strength than cotton containing 5 to 7·9 per cent. of moisture. Cotton containing less than 5 per cent. moisture also produced yarn of lower strength. Increased moisture gave an increased nep count at the cards, yet this was not apparent in the yarns produced. No apparent increase in yarn appearance has been obtained by increasing the moisture. Moisture percentage in raw cotton bears a highly significant correlation to nep count in the card webbing and to yarn strength index, and a significant correlation with fibre maturity. The addition of moisture in the picker room improves the spinning of dry cotton especially from the standpoint of yarn strength. Moisture content above 9 per cent. or below 5·5 per cent. is detrimental to good spinning.

241. THE EFFECT OF DRAFT DISTRIBUTION ON STRENGTH AND APPEARANCE OF COTTON YARNS. By L. A. Fiori. (*Text. Inds.*, **112**, 1948, p. 92. From *Text. Tech. Dig.*, v, **12**, 1948, p. 752.) Four varieties of cotton, varying in staple length from 1 in. to 1½ in., were used in making a coarse yarn (15·75s). The drafts on the drawing, roving, and spinning machines were varied, and it was found that increases in draft on drawing (4 to 8) or roving frames (8·02 to 16·3) do not affect materially the strength or grade of coarse yarn. Increases in spinning drafts (12·6 to 25·2) resulted in significantly lower skein strengths, but had little or no effect on the grade of yarn. The study confirms the advantages originally claimed for long draft spinning, namely, the introduction of "controlled" drafting during spinning. The futility of indiscriminate drafting in this process is demonstrated.

242. COTTON FIBRE: STRENGTH TESTS; COMPARISON. By J. N. Grant and O. W. Morlier. (*Text. Res. J.*, **18**, 1948, p. 481. From *Summ. Curr. Lit.*, xxviii, **19**, 1948, p. 455.) The results of the individual fibre test and the Pressley flat-bundle test have been compared for four different types of American cotton in commercial use, including a Sea Island variety. Because of the combing action in bundle preparation, cotton fibres broken in the flat-bundle test represent the long fibres in the sample. As the specific fibre strength increases with fibre length, these fibres are not representative of the strength of the sample. This increase in specific strength with increase in length is evident whether fibres are broken individually or in aggregates. The relationship between the logarithm of the individual fibre tensile strength and the logarithm of the specimen length used is inversely linear. The

flat-bundle test represents the strength of fibres whose specimen lengths were deducted to be between $\frac{1}{16}$ and $\frac{3}{32}$ inch.

TRADE, PRICES, NEW USES, ETC.

243. Raw Cotton Commission: Reorganization. (*Cotton*, M/c., 5/2/49.) The Raw Cotton Commission has announced a reorganization of its staff with the object of achieving closer contacts with spinners on the one hand, and on the other to improve the efficiency of the Commission's buying operations.

Mr. H. Arrowsmith, who has been acting general manager of the cotton department of the Commission, will be general cotton consultant to the Commission.

Mr. J. T. Porritt will be generally responsible for buying all growths of raw cotton and the management of the department.

The following will act as buyers in charge of their respective classing rooms—American: Mr. R. Thorpe. Egyptian: Mr. E. Hartley. Brazilian: Mr. W. B. Coddington. East Indian: Mr. E. N. Frimston. Other growths: Mr. Arrowsmith (*pro tem.*). Mr. F. D. Harris has been appointed buying services manager under Mr. Porritt.

Mr. C. N. Harding, as general sales manager, will be responsible for the management of the sales department, and the following will act as sales managers responsible directly to Mr. Harding for sales and estimation of requirements—American: Mr. P. E. E. Ashton. Egyptian: Mr. Coury. Brazilian: Mr. F. B. Cope. East Indian: Mr. E. N. Frimston (*pro tem.*). Sudan, Peruvian, etc.: Mr. W. R. Bland. Other growths: Mr. W. H. Howden. Mr. E. J. Richmond has been appointed acting secretary to the Commission.

244. New Cover Scheme for Cotton Spinners. (*Cotton*, M/c., 5/2/49.) By a major reorganization scheme the Raw Cotton Commission is to be divided into three main departments—buying, sales, and finance and administration—and the present cover scheme for Lancashire spinners will be replaced by a new one which will give them the option of purchasing cotton in three different ways—(1) Deferred delivery on call contract. (2) Deferred delivery on fixed price. (3) A system of cover notes. These are documents which offer spinners three or four different types of cotton which the Commission can undertake to supply within six months.

245. Cotton Linters Laminates: Properties. By M. Gallagher and R. B. Seymour. (*Modern Plastics*, 25, 12, 1948, p. 117. From *Summ. Curr. Lit.*, xxviii, 1948, p. 458.) Experiments are reported in which purified cotton linter sheets were impregnated with polyester, phenolic, and thermoplastic resins and the built-up laminates were cured after removal of solvent and/or air as required. Tensile, compressive and flexural strengths and Young's modulus in flexure were determined and the effect of specimen thickness on the strength of chemical cotton laminates is discussed. Experimental results are tabulated.

MISCELLANEOUS

246. World Cotton Production. (*Ambassador*, 12, 1948, p. 76.) World cotton production for the current season is expected to total 28 million bales—a 20 per cent. increase on the season just ended, and sufficient to satisfy the requirements of the 1948-49 season; this demand is anticipated to be between 26 and 27 million bales, approximately the same as during the 1947-48 season. The world carryover of raw cotton on August 1, 1948, was 13·8 million bales, the lowest in years. It is considered unlikely that world exports of raw cotton will attain pre-war levels in the current season, although they will probably show an increase. Cotton consumption and world trade in the coming season will be influenced by the working of E.R.P. and the trend of world food prices.

For the 1947-48 season, world production of commercial raw cotton is estimated as having been 23·2 million bales, which is 3 million bales more than for the previous

season, but 5·6 million bales below the average crop for the 1934-38 period. The 15 per cent. increases in the 1947-48 crop over the preceding season was chiefly due to expanded U.S. production (50 per cent. of the total world output), and also to expansion in the production figures of the Soviet Union and China. The U.S. crop for the coming season is expected to be 14·9 million running bales, 28 per cent. larger than the 1947 crop. The estimated world cotton crop in 1948 of 28 million bales would be 40 per cent. more than the 1945-46 figure, and only 3 per cent. below the 1934-38 average.

World consumption of commercial raw cotton through the 1947-48 season is estimated as being 26·5 million bales; this shows a small increase over the preceding season, but is 1·5 million bales below the 1934-38 average. The United States consumed 9·3 million bales, thus accounting for 35 per cent. of the world total, although showing a decline from the previous season's 39 per cent. participation.

247. WORLD FIBRES REVIEW. (Food and Agric. Org. of the United Nations, *Commodity Ser.* 9, Sept., 1948.) World production of cotton over the 1947-48 period reviewed. A summary survey is made of cotton supply and disappearance during the first three post-war years compared with the pre-war period 1934-38. Comments are made on the progress of mechanization of cotton-growing in the United States and other major cotton-producing countries.

248. QUARTERLY REVIEW OF WORLD COTTON SITUATION. (Int. Cott. Adv. Comm., Wash., U.S.A., Oct., 1948.) Summarizes the position of world cotton stocks, with notes on production, consumption and prices. Tables show estimates and forecasts of the world's cotton crops, 1947-48—1948-49, and the cotton prices in the world markets, 1946-48.

249. COTTON: QUARTERLY STATISTICAL BULLETIN, SEPTEMBER, 1948. The first issue of this Bulletin has now been received. It is prepared by the Secretariat of the International Cotton Advisory Committee in accordance with Resolution III of the Seventh Plenary Meeting of the Committee. The Committee is an international organization on which 26 countries accounting for 85 per cent. of world cotton production and 80 per cent. of world cotton consumption are represented, and has among its responsibilities the supplying of complete, authentic and timely statistics on world cotton production, trade, consumption, stocks, and prices. The Bulletin is to be based, in so far as possible, on official statistics, but will include unofficial estimates where official figures are not available.

250. QUARTERLY STATISTICAL BULLETIN, December, 1948. Contains tables covering world supply and distribution, production, consumption and exports, and imports of cotton into the principal manufacturing countries by growths.

251. TEXTILE SCIENCE: AN INTRODUCTORY MANUAL. By J. T. Marsh. (Chapman and Hall. Price 32s. From *Bull. Imp. Inst.*, xlvi, 1, 1948, p. 74.) This book is an introductory manual to the scientific aspects of modern textile production, and, as such, requires a working knowledge of chemistry and physics. It is intended as a first text-book for those who are training for a career in the textile industry, and covers the whole field from the raw textile fibres to the finished material without describing the technology of the subject in detail. The author has, however, devoted the first 81 pages to a lucid survey of the nature, chemical constitution, molecular structure and the chemical and physical properties of textile fibres. The second part of the text is devoted to an explanation of the processes used in the manufacture of yarns and fabrics. Part 3 discusses the principles involved in scouring, bleaching, dyeing, printing and drying, and the methods used in the industry. A most interesting section of the book is that on finishing, which describes the treatment given to fabrics in order to obtain special effects. The fourth part includes the description of processing such as creping, mercerizing, weighting, delustring, milling, non-felting and anti-shrink treatments, the use of artificial resins to produce crease-resisting fabrics, rubberizing, waterproofing and fireproofing. The book is amply illustrated, and there is a good bibliography and index.

252. CORONA—THE JOURNAL OF H.M. COLONIAL SERVICE. (Feb., 1949, monthly,

price 1s.) The first number of this publication opens with a foreword by Mr. Creech Jones, the Secretary of State for the Colonies, in which he writes: "This Journal will, I hope, provide a ready means whereby knowledge gained from day to day by officers at work in the field, may be put into a common pool from which all their colleagues may draw with advantage." The journal contains popular and informative articles, comments on parliamentary debates on Colonial matters, book reviews and theatre notes; advertisements are also included.

ADDENDUM

253. AFRICAN SOIL CONFERENCE. (*Crown Colonist*, March, 1949, p. 192.) Important recommendations were made at an African Soil Conference held at Goma, in the Belgian Congo, from November 8 to 15, 1948. The Conference was attended by Mr. G. F. Clay and Mr. W. A. Robertson, Agricultural and Forestry Advisers to the British Secretary of State for the Colonies, by representatives of the British African territories, and of Portugal, France and Belgium, and the French and Belgian African territories. There were also observers from the United States and from the United Nations Food and Agriculture Organization. The Conference studied the possibility of adopting a common policy in the field of soil conservation, and recommended the establishment in Paris of a bureau to co-ordinate all the information available on the subject of soil conservation and utilization. Another recommendation was the establishment of a service, which it was suggested should be conducted by the National Institute for Agricultural Studies, at Yangambi, in the Belgian Congo, to promote the application of the most up-to-date methods. In addition, it was decided that regional organizations should be established to help in working out a joint plan of action.

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METHODS AND RESULTS OF SELECTION EXPERIMENTS WITH PERUVIAN TANGUIS COTTON

PART I

A SURVEY OF PRESENT METHODS OF COTTON BREEDING AND A DESCRIPTION OF THE "MASS PEDIGREE SYSTEM"

BY

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INTRODUCTION

TANGUIS cotton is a type of *barbadense* belonging to the Pacific assemblage of this species. It is genetically similar to the cottons grown by the pre-Inca peoples of the Peruvian coast valleys, and the present type originated as a single plant selection made by Señor Fermin Tanguis in 1908 in a field of American Upland of the variety "Suave." At the time of its discovery it was said to be immune from Verticillium wilt, to be of length 1⅜ in.-1½ in. and to possess rough staple of great whiteness. The ginning percentage was said to be about 40. The yield was exceptionally high and the commercial valuation about twopence per pound more than the "Suave," which it very rapidly replaced.

In 1918 it figured in Peruvian cotton exports to the extent of 8 per cent. of the total production, and by 1933 it constituted 91 per cent. of the Peruvian crop.

Tanguis did not replace the existing cottons, Upland, native tree cottons, or Egyptian, with its original qualities unimpaired. Mechanical contamination of seed stocks at the ginneries and natural crossing with the types which it was replacing both played their part in causing degeneration, and almost before Tanguis had spread over the country, complaints began to be registered regarding the lowering of its quality and its evident heterogeneity in field culture. Attacks by wilt increased notably in some areas.

The task given to the present writer was to endeavour to restore to Tanguis the qualities which it had lost, and to improve it in other

characteristics which appeared desirable. A complete account of the origin, characteristics and results of the first three years' work has been published (Harland, 1944) and the reader is recommended to consult this Bulletin for details not possible to give here. At the same time the Bulletin has been largely drawn upon for the present article.

The Commercial Crop in 1940

When the writer examined the commercial crop in 1940 it was clear that a good deal of undesirable heterogeneity existed in the crop. The lint length was about 1 in. (Washington standards), the colour generally white, but with yellowish and brownish types so abundant in some localities that hand sorting was necessary. Large numbers of woody, late maturing, vegetative types were present, wilt was widespread, and crop yields unnecessarily low due to unsuitable genotypes. Ginning percentage was about 36·5.

General Results obtained in the Period 1940-49

Several waves of improved seed have been released from 1943 onwards and the crop is now capable of giving high yields all over the country. All coloured types and all materially undesirable types have long since gone. The yield can be well over 1,000 lb. of lint per acre in favoured localities, and can be maintained at this level for three years without replanting.

Wilt-resistant types have been bred, and selection for oil content of the seed (to be discussed in Part II) has raised the percentage of oil from 20·5 to 29·4 in the best strain. The commercial consumers are well satisfied with the present quality of the cotton, and the farmers agree that their needs have been adequately met. The writer does not wish to give the impression that he and his colleagues have been entirely responsible for the improvements effected during the last ten years. Some excellent strains have been released from the Government Station at La Molina, and where early maturity is wanted these strains are extensively grown. The writer does not believe that the pure line methods used by the Government workers meet the present or future needs of the farmers so adequately as the mixed strains produced by the Institute of Cotton Genetics. It is clear, however, that both methods should be fairly tested and that the farmers themselves should and will have the final say in choosing the varieties which they will grow.

Methods and Objectives

We were confronted with the necessity of formulating a breeding programme which would result in a rapid replacement of the existing commercial crop by new varieties which would correct the more obvious defects. If improvement was to be rapid—if the aim which we set our-

selves of distributing about 1 million pounds of new seed in three years was to be attained—it is clear that the usual pure line methodology would have to be ruled out.

The method finally evolved differs considerably from those used by other workers and from those previously used by the writer (1919) in his breeding experiments with Sea Island cotton in the West Indies. No self-fertilization has been practised and mixtures of strains are being propagated rather than pure lines.

The method can be termed "Mass pedigree selection." Some explanation is therefore necessary for such a radical departure from current methodology, and as an introduction a brief survey of the history of cotton breeding will be given.

Before the Mendelian epoch, which dates from 1900, cotton selection was carried out extensively in the United States. The method used usually consisted in selecting a single good plant, keeping the progeny separate, and if that progeny happened to conform to the standard set up in the mind of the breeder, to propagate it as a new and improved variety. The standard was preserved by continually selecting new starting points from the strain.

Continuous roguing was practised and there were even some attempts at combining the desirable characteristics of two or more varieties by hybridization followed by selection. The methods in most respects conformed to Mendelian principles, although the workers did not know this. Like M. Jourdain, they were speaking prose without knowing it. When they selected a good plant as a mother they were working on the assumption that some mothers at any rate would give a more or less uniform progeny—that is, that they were fairly homozygous for the characters desired. If they gave a bad progeny then the mother must have been heterozygous, or have been contaminated by crossing, and the whole progeny would then be discarded. In the case of progenies which were moderately uniform, plants not conforming to type were rogued out, and by breeding from the plants which remained, the chance that a plant which was phenotypically good would also be genotypically good would continually be strengthened. In other words, by strict roguing and breeding from the best, phenotypes will often, though not always, ultimately coincide with genotypes. The main defect in the method is that heterozygous forms manifesting hybrid vigour tend to be selected as parents.

The principle that the breeding value of a plant can only be stated in terms of the mean characteristics of the offspring is the basic principle of all breeding technique with plants reproduced from seeds. It is the principle of the genotype; it was known and applied by the Vilmorin school of sugar beet breeders in France long before the rediscovery of Mendelism; it has had great success in plants like cotton which are

usually more than 50 per cent. self-fertilized, and in other preponderantly self-pollinated plants. It has not worked with maize or with other preponderantly cross-fertilized plants in which the maintenance of hybrid vigour plays the principal part in maintaining yield. In these plants—according to the view held by the present writer—hybrid vigour is due to the fact that the heterozygous phase of many growth genes has an advantage over the two homozygous phases. Selection for vigour in these plants falls on the heterozygous phases of genes, and those heterozygotes have been selected which contribute most to the vigour of a predominantly heterozygous system. Any selection process, such as inbreeding, which decreases the number of heterozygous loci is thus disadvantageous. A plant such as the garden pea, *Pisum sativum*, which is almost completely self-fertilized, can stand having all its loci in a homozygous condition, since it is the various combinations of homozygous genes which have always been exposed to selection. Cotton—partly self-fertilized and partly cross-fertilized—can tolerate probably about 70 per cent, of its genes in a homozygous condition since its reaction with environment is naturally conditioned by the past history of the interaction of homozygous and heterozygous loci. If all the loci are made homozygous, vigour will be lost by the fixation of an unknown number of genes which confer vigour by their types of interaction in the heterozygous phase. The available evidence indicates a loss of the order of 10 per cent. or more in yield by the use of pure lines.

After 1900, the methodology of cotton breeding soon became dominated by the "pure line" concept of Johannsen, and Balls, working in Egypt from 1905 onwards, laid the foundation of the present pure line technique used by many cotton breeders. Doubtless largely influenced by the importance of homogeneity for industrial fibre properties, he never ceased to emphasize the pure line as the ideal towards which to aim, and was followed by the writer in the West Indies, 1915-20 and 1930-35, and by the Kearney group of workers in the United States in their work with Egyptian cotton. It may be mentioned casually that some lines of the Montserrat Sea Island cotton known as H.23 have been continuously self-fertilized since 1915-16, *i.e.*, for thirty-three generations. The Montserrat strains are not noticeably lacking in vigour, though this is decidedly augmented by crossing with unrelated strains. In the history of Egyptian cotton growing there had been a continual succession of named Egyptian varieties—Jannovitch, Nubari, Mit Afifi, Sakellaridis, Pillion, and many others. They mostly sprang into being as single plant selections, enjoyed a few years of popularity, declined, and then disappeared, to be replaced by new varieties. The life of a variety was estimated to be seldom more than ten years. Balls deduced from his genetical experiments that the disintegration or degeneration of a variety by which it lost its salient

characteristics was due to cross-pollination by different and inferior types accompanied by mechanical contamination of the seed.

Now according to Johannsen's theory, a pure line is completely homozygous for all its measurable characteristics. It is, in the language of Balls himself, something as definite as a chemical compound and as unchangeable. In peas or wheat, every plant will give an approximate pure line progeny, since these plants are self-fertilized. In cotton, a single unselfed plant may perhaps be up to 70 per cent. pure depending on the amount of cross-pollination. A single selfed plant may perhaps be 85 per cent. pure in the first generation of selfing. Two more generations of selfing will produce a commercially acceptable approximation to a pure line; though natural or artificial selection could still cause changes of some magnitude.

The doubling of almost sterile haploids by colchicine to produce fully fertile normal diploids is simple and practicable in Sea Island cottons, where they occur fairly frequently. These doubled haploids would be the nearest approach to pure lines—apart from chromosomal abnormalities—yet obtained in cotton.

Balls saw clearly that when a pure line had been isolated with given agricultural and industrial properties, it would not go through the degeneration process that the familiar named varieties had gone through. It could be preserved indefinitely as long as foreign pollen was excluded. Once a good line was obtained it was good for ever. There was another reason which led Balls to advocate pure lines—an industrial reason. In a popular exposition of his work (1918) he refers to the spinning properties of some of his pure lines. He says, " These pure strains when put through the spinning mills behaved far better than expert judgment and handling of lint had anticipated." A sample of No. 77 regarded as very bad by the grader " . . . headed the list of six samples in the test, giving the strongest yarn of any." From these and other corroborative results it was argued that the spinning properties of pure lines were so superior to those of mixed strains that they must be grown for the sake of the industry. As a corollary it was held that depreciation in spinning properties proceeded *pari passu* with the amount of genetical contamination of the strain. The fetish of pure lines spread to most cotton-growing countries, and " like the letter H is now treasured by many who formerly knew it not." A few murmurings against the strict application of the pure line concept to cotton breeding have lately been heard, and as workers are often confronted, as this Institute was, with the necessity, not only of producing practical results in a short time, but also with the need for rapid and oscillating adjustments to both agricultural and commercial needs, it became necessary and urgent to examine the philosophical bases of the pure line concept in order to see whether more rapid methods could be devised. It was concluded that,

for this particular sort of cotton, the pure line methodology should be abandoned and new ideas put into practice.

A Critique of the Pure Line Concept as Applied to Cotton

Are pure lines necessary for (*a*) the consumer, and (*b*) the grower ?

(*a*) The Consumer

As stated above, it has been supposed that the elimination of genetical variability in fibre properties, leaving only the environmental source of variability, confers superior spinning properties. The two most important properties of the cotton fibre related to spinning properties are length and fineness, expressed as hair weight per centimetre, or mercerized diameter determined by the method of the writer (Calvert and Harland, 1924).

1. *Length*

It is known that the variability of length on a single seed is practically as great as that found in a commercial bale of the same commercial length, although the commercial bale contains fibres from plants of very differing genetical composition in respect of length. The environmental variability, resulting no doubt from competition between fibres for nutrients, is practically as great as that resulting from the interaction of both genetical and environmental causes in a mixed population. Here environment swamps heredity. It is not disputed that it may be desirable to reduce variability from plant to plant as much as possible, and it is probable that selection in favour of diminished variability even within single plants might be effective. It is, however, highly doubtful whether the spinning value of such selection products would be materially enhanced. Such is the view of Balls (1928), who found that spinning samples in which the fibres had been mechanically equalized in length did give yarns of somewhat greater strength, but the superiority of sorted cotton was not sufficiently great to warrant the adoption of the process on a mill scale.

There is thus no reason to believe that lines genetically pure for lint length would be much superior to mixed populations of the same commercial length.

2. *Hair weight per centimetre*

It may be argued that if greater uniformity of length is of little importance, even if attained, pure lines must be characterized by a greater degree of uniformity in what appears to be a much more important character, namely hair weight per centimetre, but the reduction in hair weight variability in pure lines is by no means as great as was supposed. It can be demonstrated that on a single seed of Sea Island cotton the variability of hair weight in groups of hairs taken from

various positions is equivalent to the range of hair weight met with in passing from the finest Sea Island to Upland. This variability is again presumably due to inter-fibre competition for nutrients at different places on the seed coat. There is also a strong environmental effect on hair weight, and it was shown by F. S. Parsons (unpublished) as early as 1925 that the hair weight varied with water supply. With successive increments in the amount of water, the fibres were long, and of low hair weight, decreasing in length and increasing in hair weight per centimetre as water supply decreased.

In a mixed population a given length class would include plants with a much greater range in hair weight than in a pure line, for although length and fineness are generally negatively correlated, it is possible to find in a mixed crop plants with high or low hair weight even if the length is the same. This decreased hair weight variability in a given length class is probably the most important cause of the superior spinning quality of pure lines, and this is the most powerful argument in favour of pure lines in countries which grow fine cottons of Egyptian and Sea Island type. Our first conclusion, therefore, is that, from the industrial standpoint, the pure line concept has been of the greatest possible importance to the fine cotton trade, and the policy of pure lines should be maintained.

But in regard to coarse cottons it has apparently never been demonstrated that pure lines spin better than mass selected populations. The argument for decreased variability of a given length class has much less force, since if hair weight is already high it becomes increasingly difficult to find plants greatly exceeding the mean value. In other words, the more hair weight is increased the more difficult it is to impair spinning value. It is probable that in low counts, which have a large number of hairs per cross section, the presence of variability in hair weight is of minor significance, whereas the presence of a few hairs of high hair weight in a very fine yarn might considerably impair the strength.

To sum up: In coarse cottons of medium to short staple the pure line concept applied to fibre properties is probably of minor significance. It is therefore possible to grow mass-selected populations without detriment to the industry, provided that standard values for length and hair weight are maintained in the selected material, and provided that precautions are taken to reduce to a minimum genotypes not conforming to the standards laid down.

Some agricultural considerations bearing on this subject will finally be discussed. Many countries grow extremely mixed cottons which are used in the industry without special comment on, or complaint about, their spinning properties. The State of Rio Grande do Norte in Brazil grows in the coastal regions a mixture of hybrids of Bourbon (*G.*

purpurascens) which in the fields is so heterogeneous that no two plants are alike. In the State of Sao Paulo the two former standard Uplands, known as Texas and Express, were intensely mixed. Commercial cottons of this type have always been acceptable to the industry and bring a price in accordance with their commercial length and grade. In the Grenadines a mixture of *purpurascens* and *barbadense* is known as Marie Galante and is the common commercial cotton. The average commercial length is greater than that of standard American Upland and it is sold for a higher price than the latter. In India, fields of Asiatic cotton are often strongly contaminated by *hirsutum*, and this is thought to enhance the spinning value of the cotton by a component which lowers the general hair weight of the mixture.

On the other hand, during the first world war, when Sea Island cotton was used in the manufacture of aeroplane wings, complaints were received that the spinning qualities of Barbados cotton were not up to standard. Inspection of the fields disclosed the presence of many rogues derived from Bourbon hybrids. Pure seed was therefore imported from St. Kitts and the trouble ceased. All these facts show that mixtures can be grown in shorter and coarser cottons but not in the longer and finer ones.

(*b*) The Grower

It has been concluded that pure lines are industrially desirable in long fine cottons of the Sea Island and Egyptian groups on account of their greater uniformity in fibre properties, but that in coarse cottons the importance of the pure line has been over-emphasized. Let us examine in greater detail the situation from the growers' point of view. What were the advantages of the pure line? The pure line is a standardized product which can be relied on to interact with the same environment always in the same manner. It follows therefore that the behaviour of a pure line can only be predicted if the environment is predictable. The chief environmental factors affecting cotton are water supply, temperature, length of day, the subterranean environment—the physical, chemical and organic properties of the soil—and, finally, the varying incidence of insect pests and diseases. Of these, water supply and temperature are perhaps the most important, and in Peru the growing conditions are perhaps more uniform than in most countries, since the crop is grown under irrigation in a tropical region. Temperatures are perhaps sometimes too low; at times atmospheric humidity is too high; sunshine is sometimes insufficient. But whatever the characteristics of the environmental complex may be, they are not static but dynamic. The environment may be described as a constantly changing succession of environmental niches to which the genotypes are being as constantly adjusted by differential survival rates.

The practical conclusion for the plant breeder is that he should, so far as is possible, adjust the genetic variance of his crop to the environmental complex with which it has to cope, and above all to create a population which interacts to the best advantage with the most frequently occurring type of season—if there is one—that is, the "modal season."

If the environmental variation is very great, the pure line will be at a great disadvantage. It cannot respond to changing conditions by adjusting its gene frequency systems: its heredity is constant. But, it may be remarked, what about degeneration in mixed populations? If the characteristics of a mixed population of cottons are determined, the lint length might be, let us say, 1 in. Now if that mixed population is merely maintained without selection there is no reason to suppose that the length will go down and down, or that the boll size will get smaller, or that there will be any change in such characters as ginning percentage. If the crop has been grown in the same district a long time, all these characters will long ago have come into equilibrium with the environment—a balanced system of gene frequencies has been set up. Marked changes can only occur for two reasons: One, when the system of gene frequencies introduced into the locality to fit a given environmental niche do not in fact fit that niche. In that case selection pressure causes changes in the relative proportions of the genes determining various characters, and new systems are set up to fit the environment. The other change which can occur is due to mutation to genes which are either neutral or which enhance the efficiency of the plant from the point of view of the reproductive rate. If mutation unopposed by selection interferes with commercial characteristics, the cotton is said to be degenerating. If changes, whether adaptational or mutational, are desirable from the point of view of the grower or consumer, the cotton is said to have acclimatized; if undesirable, it is said to have degenerated.

To decide between the pure line and the mixed population entails a further discussion of what sort of pure line should be aimed at. Can we be sure that the pure line selected is the best that can be obtained, *i.e.*, that it does have advantages which render it superior to a mixture?

In respect of most measurable characters it can be demonstrated that the phenotypes of a mixed population fall on to a normal frequency curve. In this kind of curve which is, of course, the familiar "cocked hat" shape produced by the binomial expansion of $(1+1)^n$, the mode and mean coincide, and for any given character half the population is above the mean and the other half below the mean of the general population. In a population of strains, the frequency distribution of the means of the strains follows the same rule as the distribution characteristic of single plants, except that the standard deviation is smaller.

Now if we begin with a mixed population and the objective is this comparatively modest one—that eight measurable characters are required to be either above the average, below the average, or else fall into the central area after the upper and lower quartiles are cut off, beginning with a population of 1,024 strains—it can be shown that only four strains will pass the test.

We have the following situation:

Character.	*Number of Strains.*	*Passed Test.*	*Failed Test.*
Lint length	1,024	512	512
Boll weight	512	256	256
Ginning per cent. ..	256	128	128
Whiteness	128	64	64
Fineness	64	32	32
Precosity	32	16	16
Yield	16	8	8
Wilt resistance	8	4	4

If we are forced to adopt the pure line technique it is among the four residual strains that we must look for the *one* strain which is to be multiplied to the exclusion of the rest.

A survey of cotton-breeding literature leads to the conclusion that the extreme rarity of a line conforming to only reasonable standards in respect of only eight characters has seldom been adequately appreciated. The number of strains worked with has, with rare exceptions, been far too small. In most cotton-breeding work, inbreeding has fixed genes so rapidly that the necessary plasticity to secure the preservation of essential characters has been irrevocably lost.

It is thus a simple deduction from elementary genetics that selection should begin with 1,000 or more lines in order to get even one or two superior ones. Examination of existing data regarding the mode of origin and statistical attributes of such pure lines as are in commercial cultivation inevitably leads to the conclusion that they have lost characters which they should possess, and possess some undesirable characters which have been unavoidably fixed during the selection process.

There are undoubtedly many gene complexes of a physiological, bio-chemical or morphological nature which are (*a*) not known to be important at the time of selection, (*b*) not capable of accurate measurement, or (*c*) important as a reservoir which can be drawn upon at any future time for the incorporation of characters later found to be desirable. If, for example, a mixed population has such a safety margin of genetical variability, it will be possible to modify it in almost any number of previously unforeseen directions. When the main commercial characteristics are at the desired level, selection can begin on such characters as oil content of the seeds.

There is another point of extreme importance to the plant breeder,

and that is, that each act of self-fertilization automatically fixes half the genes which are present in a heterozygous state, whatever that number may be. Now, since the physiological effects of these genes fall upon a normal curve in regard to their combinatory properties—that is, half the combinations are above the average in efficiency and half below—it follows that any plant selected at random and self-fertilized must have about 25 per cent. of physiological genes worse than the average, either alone or in regard to their combinatory properties. It is not possible to avoid this undesirable stabilization if self-fertilization is practised, and it is this fact, more than any other, which must make the plant breeder pause before he commits himself to the pure line policy in any plant subjected to a considerable degree of natural crossing.

Although the above principles are deducible from elementary text-books of genetics, it is often surprising to see the extent to which they are ignored or disregarded in actual plant-breeding practice. Indeed, much selection has been carried on without regard to genetical principles at all. Very often a new variety has originated from a single plant for no other reason than that the selectionist liked the looks of it. This procedure has often been applauded in certain circles and it has even been supposed that some plant breeders possess a special " flair " for selection which enables them to dispense with genetical methodology. It must now be obvious that selection based on the characters of single plants—flair or no flair—entirely disregards the complicated genetical structure of populations, and while not useless, since it has accidentally produced occasional striking successes, is usually perniciously inefficient. If plant breeding were no more than this, there would be no need of genetical instruction at centres of higher learning.

Further Considerations and Summary

In view of what has been said above, the conclusion was arrived at that the march of selection should be along the following lines;

1. That pure line selection should not be practised, but that a mixture of strains should be multiplied, each strain having to conform to a series of specified genotypic standards before acceptance as a component of the mixture.

2. That a series of norms should be established and that these should cut off the frequency curve *of means of strains* for the characters at a varying position, dictated by the importance of the character in question and by the urgency with which progress was deemed necessary. In some cases, as in yield, all lines would be discarded which fell below the mean of the general population of lines. In others, the lower quartile could be discarded; in still others only the upper quartile would be retained.

The considerations upon which this methodology is based—a system which may be termed "mass pedigree selection"—may be briefly outlined as follows:

Continuous selection by this method for any measurable character tends to produce a system of gene frequencies resulting in the manifestation of the character at a higher level through the elimination of alleles, the combinatory effects of which are ordinarily antagonistic to the standards laid down for the character.

If, for example, it is desired to increase the lint length of a commercial variety, grow a large number of progeny rows: put the average values of the lines in the form of a frequency curve: eliminate all lines below the general arithmetic mean and mix the rest to form a new population. We get a new mixed population with the lint length at a higher level which will be permanent if there is no strong contra-selection effect, which for this character does not seem important—at least for a few generations. What has been done is to establish a new system of gene frequencies within which natural crossing between lines should not lower the new level.

How the method of mass pedigree selection worked in Peru will be discussed in Part II of this paper.

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INDIAN COTTON POSITION—PAST AND PRESENT

BY

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COTTON has been grown in India from times immemorial, and undivided India, before the partition, ranked as the second largest cotton-growing country in the world, being next only to the U.S.A. Before the war, out of a total cultivated area of 350 million acres, about 20-24 million acres, or roughly 7 per cent., used to be annually devoted to the production of this crop. The main cotton-growing Provinces were Bombay, Punjab, the Central Provinces and Berar, Central India, Madras, Sind, the United Provinces and the States of Hyderabad, Baroda and, latterly, also Mysore. A picture of cotton cultivation in the different parts of undivided India can only be obtained by reference to the climatic conditions, soil types and the varieties grown; each Province or each cotton tract has its own peculiar characteristics which are reflected in the type and quality of the cotton produced. Except in the plains of the Punjab, Sind and the United Provinces, and in a limited area in the Madras Province, irrigation of cotton is not practised, indeed the means of giving it may be said not to exist. The whole of the crop is, therefore, dependent upon the annual monsoon. Cotton varieties cultivated in India belong to three species, viz., *Gossypium arboreum* L., *Gossypium herbaceum* L. and *Gossypium hirsutum* L. Water supply and the type of soil are the chief factors in the cultivation of cotton and these introduce an endless variety of conditions. The quality and type produced vary from tract to tract and in certain months of the year cotton is at the same time being sown and harvested in different parts of the country.

Trading in raw cotton and the cotton mill industry are concentrated in Bombay. The development and prosperity of the island of Bombay are in large measure due to the part played in its economy by King Cotton. In a sense, the history of cotton and the cotton mill industry is the history of India during the past 150 years, so dominant has been the effect of the economics of raw cotton on the economic history of India, especially of Bombay. Organized markets, trade associations,

improvements in processing and marketing, development of roads and railways, all owe their origin and expansion directly or indirectly to the requirements of India's most important cash crop—cotton. Trading in cotton is as highly organized and as well developed in Bombay as in any cotton-growing country in the world. The credit for this goes to the astute business men of Bombay connected with cotton and to the East India Cotton Association.

Improvement in Quality

There are stories of India in the very early days producing some of the finest staple cotton in the world. Authentic scientific records, however, show that much of the cotton grown in India in the eighteenth century was of the mixed short staple Asiatic types. Since then, however, the character and quality of Indian cotton have undergone a considerable change and the bulk of the cotton now produced is of the medium staple varieties. The history of cotton improvement in India goes back to the days of the East India Company, when sporadic attempts were made to introduce American cotton in certain parts of the country. In those days, however, meteorological environment was but little studied and less known. The excessive zeal displayed by amateurs in introducing exotic cottons into areas where they never could have been other than ultimate failures unfortunately placed insurmountable difficulties in the way of cotton improvement in subsequent years. No real attempt on any scientific lines was or could be made to improve Indian cotton until the beginning of the present century, when a Department of Agriculture was established in India. From that time onwards increasing attention has been paid to the improvement of cotton in respect of both quality and yield. Plant breeding for the improvement of the race of the plant was, however, but little understood in the earlier days, and improvement in the first few years was, therefore, confined mainly to the agronomic and cultural side. The conditions arising out of the first World War, 1914-18, however, impressed upon the Government of India the necessity that India should grow better staple cotton and this finally led to the formation of the Indian Central Cotton Committee (1921). The first thing that Committee did was to arrange for a well-directed and co-ordinated effort for the improvement of the race of the cotton plant by the application of the technique and principles of plant breeding. Rapid improvement in the quality of Indian cotton followed year by year and led to the evolution, development and spread of the improved varieties, Suyog, Jarila, Vijaya, Jayawant and Gadag No. 1, in Bombay Province; Sind-Sudhar, 289-F, including M.4, Sind-American 4-F., 27 W.N., L.S.S., Victory and Mollisoni, in Sind and the Punjab; Verum 434, Buri and Jarila in the

Central Provinces; Cambodia, Co.3, Co.4, Karunganni 1, N.14, H.1 and Cocanadas X.20 in Madras; C.520 and Perso-American in the United Provinces; Gaorani 6 and Parbhani-American in Hyderabad State; 1027 A.L.F., B.D.8, B.9. and Wagad 8 in Baroda.

Improvement in Yield

As already stated, most of the cotton in India is grown under rain-fed conditions and the yields vary enormously from tract to tract and year to year, depending upon the vagaries of the monsoon. In the Punjab of the past, for instance, where 92 per cent. of the area was irrigated, and in Sind where practically the entire crop is grown under irrigation, 200-250 lb. of lint per acre was regarded as the normal yield. In the Hyderabad State, on the other hand, where little cotton is grown under irrigation, the normal yield is around 60 lb. per acre. With the introduction of crop rotations and improved cultural methods, however, some improvement has been recorded in the yield per acre. Whereas, for instance, in the quinquennium 1922-27, the recorded average yield of cotton in India was 87 lb. of lint per acre, the average yield, in the quinquennium 1942-47, was nearly 100 lb. per acre. Compared with other cotton-growing countries, however, the yield per acre of cotton in India is ridiculously low. The average yield in the U.S.A. is 293 lb.; in Egypt 531 lb. and in the cotton-growing areas of the Soviet Union 322 lb. per acre.

Indian Cotton Position before and during World War II

On the average of the five years ending 1938-39, the annual area under cotton in India was some 24·6 million acres. The average production was estimated to be 6 million bales. Indian mill consumption of Indian cotton during the same period averaged 2·8 million bales annually and exports were reckoned at 3·3 million bales per annum. The outbreak of World War II, which coincided with the commencement of the cotton season 1939-40, had no immediate appreciable effect on the cotton position. In the following season, viz., 1940-41, however, the crop was larger by 20 per cent. and, at the same time, with the spread of war, the Continental markets were now shut off to Indian cotton. These markets, not including the United Kingdom, used to take some 0·91 million bales of Indian cotton, the bulk of which was of the short staple varieties. The loss of the Continental markets was offset to the extent of 570,000 bales by the increased consumption of Indian cotton by mills in India. Over half of the increased consumption was accounted for by medium and long staple cottons. The position worsened in the 1941-42 season, when the Far Eastern markets too were closed to Indian cotton as a result of the entry of Japan into the war. The position of short staple

cotton now became serious, for the average annual exports of short staple Indian cotton to Japan used to be of the order of some 1,630,000 bales. The question of adjusting, as far as possible, the supply of short staple cotton to probable demand had, therefore, to be seriously considered. An appeal was made to the cultivators to reduce the area under short staple cotton by at least 50 per cent. This appeal, coupled with the Grow More Food Campaign undertaken by Government on a country-wide scale to meet the food shortage in the country, stoppage of facilities for the movement of unwanted short staple cotton to Bombay, and the replacement of the Broach, Oomras and Bengals contracts by the Indian Cotton Contract with fine Jarila $\frac{7}{8}$ in. staple as the basis, brought about a marked reduction in the total acreage under cotton. The target aimed at was almost realized, inasmuch as the cotton area in 1942-43 declined by 4,948,000 acres compared with that of the previous year, reduction in the production of short staple cotton being nearly 50 per cent. Despite the reduced crop and the increased consumption of Indian cotton by mills in India, which reached the record figure of 4,037,000 bales in 1942-43, stocks of cotton held by the trade began to accumulate and on August 31, 1943, amounted to 2·9 million bales. The accumulation continued, aggravated by a higher crop and lower mill consumption in the following year, and the stocks of Indian cotton held by the trade on August 31, 1944, were estimated at 4 million bales. Further reduction in cotton acreage was inevitable. As a result of the Bombay Growth of Foodcrops Act, which prescribed, by law, definite proportions for food and non-food crops on individual holdings, and the action taken by other Provinces and States to increase the production of food grains by, *inter alia*, diversion of the acreage under non-food cash crops to food and fodder crops, the cotton area in 1944-45 came down to 14·8 million acres, which was further reduced to 14·5 million acres in 1945-46. The war had now ended, but the aftermath of war brought in its trail problems which did not permit of any changes in the policy regarding production of cotton *vis-à-vis* the food grains.

Looking at things in retrospect, however, it would seem that the war actually helped the improvement of the quality of Indian cotton in the sense that it accelerated the rate of progress of the extension of superior varieties of cotton, thus bringing about a better balanced production of the various types of cotton in the country. The proportion of cotton of staple length $\frac{7}{8}$ in. and above to the total production increased from 37 per cent. in the year 1938-39 to 70 per cent. in 1945-46. The production of medium and long staple cotton increased by 30 per cent. as compared with 1938-39. Under short staple cotton, the reduction was by nearly 62 per cent., during the same period. Similarly, the production of cottons of staple length 1 in. and above, which was

260,000 bales in 1938-39, went up to 390,000 bales in 1945-46. The outstanding feature of the conditions created by the war was the phenomenal spread of medium staple varieties and particularly of the improved variety Jarila in the Oomras tract of Khandesh, Central Provinces and Berar and Hyderabad State. In 1938-39, the production of such varieties in the areas mentioned was only 3,000 bales compared with 381,000 bales in 1945-46, the corresponding figures for short staple Oomras being 1,064,000 and 216,000 bales, respectively.

The Indian mill industry, too, witnessed a considerable expansion during the war. The quantity of Indian cotton consumed by mills in India rose from 3,151,065 bales in 1938-39 to the peak figure of 4,306,831 bales in 1942-43. Thereafter, the mill consumption of Indian cotton was at a lower level, the figure for 1945-46 being only 3,871,022 bales.

After Partition

In August, 1947, India attained independence. The division of the country into the Dominions of India and Pakistan, however, has created problems of no small magnitude as regards supplies of raw cotton to mills in the Dominion of India, since the better varieties of Indian cotton were mostly produced in the tracts which now form part of Pakistan. The position even of undivided India as regards supplies of home-grown raw cotton of suitable quality required by the Indian mills was never too happy, in view of the preponderatingly large quantities of short or low grade medium staple varieties grown in the country. The division has naturally gravely aggravated the position, and unless India can turn to and produce adequate quantities of cotton of improved quality within her own territories to take the place of at least some of the cottons which she has lost to Pakistan, the Indian cotton mill industry will have to face a very serious situation which may alter its whole future course. The total area under cotton during 1946-47, before the partition of the country, which took place on August 15, 1947, was 15,038,000 acres. Of this, 11,671,000 acres were in the Indian Union (including Hyderabad State), and 3,367,000 acres in Pakistan. The total area under irrigated cottons in the undivided India in the same year was about 4,100,000 acres, of which 3·3 million acres were in Pakistan. It will thus be seen that, as a result of the partition, slightly less than one-fourth of the total area and over four-fifths of the area under irrigated cottons in India of the past has gone to Pakistan. On the basis of the cotton area in undivided India in the pre-war year, 1938-39, Pakistan's share would come to about 15 per cent. of the total cotton acreage and nearly two-thirds of the area under irrigated cottons. The effect of partition on the cotton supply position in India is illustrated by the following table, which shows the production

of cotton (in thousand bales) during 1946-47 in (1) undivided India, (2) the Indian Union and (3) Pakistan:

Staple Lengths.		*Undivided India.*	*Indian Union.*	*Pakistan.*
$\frac{7}{8}$ in. and above	Actual	990	450	540
	Per cent.	*23*	*17*	*34*
Below $\frac{7}{8}$ in. and above $\frac{11}{16}$ in.	Actual	2,090	1,300	790
	Per cent.	*50*	*50*	*49*
$\frac{11}{16}$ in. and below	Actual	1,120	850	270
	Per cent.	*27*	*33*	*17*
Total of all Staples	Actual	4,200	2,600	1,600
	Per cent.	*100*	*100*	*100*

These data show that the Indian Union's share of undivided India's production of cotton of staple lengths "$\frac{7}{8}$ in. and above," "below $\frac{7}{8}$ in. and above $\frac{11}{16}$ in." and "$\frac{11}{16}$ in. and below" formed 45, 62 and 76 per cent. respectively. As regards cotton of staple length 1 in. and above, the Indian Union and Pakistan's production amounted to 100,000 and 200,000 bales respectively. While the Indian Union's share of the total crop of undivided India in 1946-47 was only 2,600,000 bales, its mill consumption accounted for 3,860,000 bales, which is 98 per cent. of the total mill consumption of undivided India, amounting to 3,940,000 bales. In the table below are given the details of the mill consumption of cotton in the Indian Union, classified according to staple length, in 1946-47:

MILL CONSUMPTION OF COTTON IN INDIAN UNION IN 1946-47 (in thousand bales).

Staple Lengths.	*Indian Union Cotton.*	*Pakistan Cotton.*	*Other Foreign Cotton.*	*Total all Cottons.*
$\frac{7}{8}$ in. and above	390	420	700	1,510
Below $\frac{7}{8}$ in. and above $\frac{11}{16}$ in. ..	1,250	560		1,810
$\frac{11}{16}$ in. and below	540			540
Total (all staples)	2,180	980	700	3,860

It will be seen that, on the basis of the consumption in 1946-47, the Indian Union is dependent on Pakistan cotton to the extent of 980,000 bales (420,000 bales of staple length $\frac{7}{8}$ in. and above, and 560,000 bales of staple length below $\frac{7}{8}$ in. and above $\frac{11}{16}$ in.) and other foreign cotton to the extent of 700,000 bales, mostly 1 in. and above in staple.

The position regarding production and consumption of cotton in the Indian Union in 1947-48 is indicated below (in thousand bales):

	Long Staple ($\frac{7}{8}$ *in. and above*).	*Medium Staple* (*below* $\frac{7}{8}$ *in. and above* $\frac{11}{16}$ *in.*).	*Short Staple* ($\frac{11}{16}$ *in. and below*).	*Total.*
Production in Indian Union ..	500	1,660	1,030	3,190
Mill consumption:				
Indian Union Cotton	500	1,840	570	2,910
Pakistan Cotton	440	240		680
Other Foreign Cotton	620			620
	1,560	2,080	570	4,210
Extra Factory Consumption ..		40	230	270
Exports		450	500	950*
Total	1,560	2,570	1,300	5,430

It will be seen that as against the total production of 3,190,000 bales in 1947-48 from 11 million acres, the internal requirements (including extra-factory consumption) amounted to 4,480,000 bales, leaving a deficit of 1,290,000 bales. Out of the production, about 230,000 bales of short staple cotton were surplus to internal requirements. These are usually exported. If allowance is made for this, the real deficit is of the order of 1,520,000 bales. This deficit was met, in 1947-48, by the use of 680,000 bales of Pakistan cotton (440,000 bales of long staple and 240,000 bales of medium staple), 220,000 bales of medium staple Indian Union cotton from the previous carryover, which would otherwise have been imported from Pakistan, and 620,000 bales of other foreign cotton of long staple.

THE FUTURE

It is not likely, as far as one can foresee at present, that the types of cotton imported from countries other than Pakistan can be successfully grown in the Indian Union, at any rate for some time to come. The import of 600,000 to 700,000 bales of these varieties will, therefore, have to be continued until, as a result of the research going on in the Madras Province, Bombay and Mysore State, suitable improved varieties of cotton can be developed for cultivation in the Union on a large scale. The dependence on Pakistan can, however, be reduced, as, with the exception of a very small quantity, Pakistan cottons can be replaced in the near future by the production of similar varieties in the Indian Dominion. At the current level of consumption of Indian cotton in mills in India, the total annual requirements in respect of long and medium staple cottons ($\frac{7}{8}$ in. and above) from Pakistan by mills in the Dominion of India is estimated at 940,000 bales, classified by varieties as shown in the following table:

* The exports were mainly from previous carryover.

	(*In thousand bales of 400 lb. net*).
Punjab-American 4F	271
Punjab-American 289F/43, 199F, 124F, L.S.S. ..	412
Sind-American 4F	34
Sind-American 289F-1, M.4 and N.T.	223
Total ..	940

Punjab-American 4F from West Punjab and Sind-American 4F (total 305,000 bales) of staple length $\frac{3}{4}$-$\frac{7}{8}$ in. can be replaced by Jarila (staple length $\frac{3}{4}$-$\frac{7}{8}$ in.), if the production of Jarila is correspondingly increased. In 1945-46 production of cotton in East and West Khandesh and Nasik districts of the Bombay Province (where almost the entire area is now under Jarila) dropped, for reasons mentioned earlier, to 47,000 bales. In 1941-42 the production was 267,000 bales. There is thus scope for extension of Jarila in these districts to the extent of an additional 220,000 bales. In the Central Provinces and Berar, too, it is possible to increase the production of Jarila. Production of cotton in these provinces in 1941-42 amounted to 988,000 bales (of which 152,000 bales were of medium staple) against 518,000 bales in 1945-46 (of which 400,000 bales were of medium staple). By extending the acreage under cotton, a further increase of 200,000 bales of medium staple over the 1945-46 figure is possible. Apart from the additional quantities which can be obtained from the sources mentioned above, it is quite feasible to augment the production of medium staple cotton of the type of 4F at the expense of short staple cotton. For instance, in the Ferozepore District, which falls in East Punjab, about half of the total cotton area of 130,000 acres in 1944-45 was under 4F and the other half under *desi*. As, however, almost the entire cotton tract in this district is irrigated, the replacement of *desi* by American cottons here should present no serious difficulty. If this is done, the available supply of 4F can be raised by some 40,000 bales. It may be observed in passing that the area under American cotton in this district increased from 17,000 acres in 1941-42 to 68,000 acres in 1944-45. Some 160,000 bales of short staple cotton produced at present in the Dholleras tract, comprising Ahmedabad District, Mehsana District of Baroda State and part of Western India States Agency, can be replaced by K.72-2 and Patrap cottons, which are types similar to 4F. Schemes for the extension of these medium staple varieties have been approved by the Indian Central Cotton Committee. It is expected that under those schemes over 75 per cent. of the area will be covered by these two types at the end of five years. In the Hyderabad State, Jarila, which was not grown on a commercial scale prior to 1942-43, yielded 18,000 bales in 1945-46 by replacing Hyderabad Oomras. As the total production

of Oomras cotton other than Jarila in the State decreased from 295,000 bales in 1941-42 to 112,000 bales in 1945-46, there is scope for increasing the production of Jarila in this State at the expense of ordinary Oomras to the extent of, say, 50,000 bales. Further, in the Ceded Districts of the Madras Province a scheme for breeding Cambodia cotton to replace the existing short staple types is in operation. The work, however, is still in the experimental stage. It may be assumed that the replacement of 4F from Pakistan by similar cottons in the Dominion of India is quite feasible. The time that will be taken for this will depend on the speed with which the schemes are carried out. The requirements in respect of American varieties other than 4F mentioned above, viz., 289F/43, 199F, 124F, 289F-1, M.4, N.T. and L.S.S. (staple length from $\frac{7}{8}$ in. to $1\frac{1}{16}$ in.) are estimated at the current level of consumption at some 635,000 bales. Of the total quantity, some 100,000 bales may be classified as long staple (over 1 in.), the remainder falling within the group $\frac{7}{8}$ in. to 1 in. The only areas in the Indian Union which can at present produce over 1 in. cotton are the Cambodia tract of the Madras Province and the Irwin canal tract of the Mysore State. In the former tract, some 23,000 bales of Co.3 and Co.4, over 1 in. in staple, are produced. As this crop is mainly a summer crop, grown in rotation with paddy, the possibility of extending the area under it is limited, since water supply is obtained from wells and tanks. A scheme is in operation in this tract for production of quality cotton superior to Co.3 and Co.4. The anticipated deficit in the supply of $\frac{7}{8}$ in. to 1 in. cotton can be met by increasing the production of such types as Cambodia and M.14 (Madras Province), Jayawant, Surti-Suyog and Broach-Vijaya and Gadag 1 (Bombay Province), Buri (Central Provinces and Berar) and Gaorani (Hyderabad State). The scope for this increase is illustrated in the following table:

Name of Variety.	*Production in thousand bales of 400 lb. net.* 1941-42.	1945-46.
Cambodia	256	159
M.14	4	4
Kumpta-Jayawant	152	34
Gadag-1	29 *	15
Surti-Suyog	151	60
Broach-Vijaya	290	109
Buri (including Cambodia)	18	44
Hyderabad Gaorani	142	84
Total ..	1,042	509

Summarizing the position, long and medium staple cotton from Pakistan at present consumed by mills in India may be classified under three staple length groups (i) $\frac{3}{4}$ in. to $\frac{7}{8}$ in., (ii) $\frac{7}{8}$ in. to 1 in., (iii) over

* Includes Upland other than Gadag-1.

1 in. It is possible to increase the production of cotton under group (i) at the expense of short staple cotton to the extent necessary to make India independent of supply from Pakistan, but the process will take some time. Under the conditions in which cotton is grown at present, *i.e.*, without irrigation, the supply of cotton under groups (ii) and (iii) cannot be increased at the expense of short staple cotton. The areas where increased production of cottons under group (i) can be looked for at the expense of short staple cotton are Ferozepore District of East Punjab, the Dholleras tract comprising the district of Ahmedabad, Mehsana district of Baroda State, part of Western India States, Hyderabad State and the Ceded districts of the Madras Province. In order, however, to become independent of Pakistan, provision will have to be made for an additional annual production of 440,000 bales of long staple and 460,000 bales of medium staple cotton. To achieve this object, the Indian Central Cotton Committee has recommended an overall increase of 4·0 million acres (as compared with the area in 1946-47, viz., 11·7 million acres) distributed according to different varieties as shown below:

Name of Variety.	*Staple Length.*	*Proposed increase over* 1946-47 (*in thousand acres*).	*Probable increase in production* (*in thousand bales*).
Cambodias Co.2, Co.3 and Co.4	1 in. and above	100	40
Surti-Suyog	$\frac{7}{8}$ in. to $\frac{31}{32}$ in.	300	68
Cambodias		150	75
Kumpti Jayawant		700	110
Buri (including Cambodia)		250	46
Hyderabad Gaorani ..		400	63
Hyderabad American ..		50	8
Broach Vijaya	$\frac{13}{16}$ in. to $\frac{27}{32}$ in.	300	58
Westerns and Northerns ..		200	27
Karunganni		50	12
Jarila, Verum or H.420 ..		1,200	253
Dholleras	Below $\frac{13}{16}$ in. and above $\frac{11}{16}$ in.	300	50
Total		4,000	810

The matter, however, is closely linked up with the question of increasing the production of food grains in the country in order to achieve self-sufficiency by the end of 1951, which is the goal the country has set for itself. Any proposal for increasing the acreage under cotton in the Indian Union has, therefore, to be looked at from the point of view of the repercussion it will have on the food position of the country. Irrigation facilities and fertilizers, essential for increasing the acre-yields of crops, have, of necessity, to be reserved for the time being for food crops. Proper tillage and judicious rotations are, therefore, the only means the cultivator has at his disposal to step up the yields of cotton. Spectacular

results in this direction may, therefore, be ruled out for the present. In the meanwhile, the supply position of cotton in the Indian Union is becoming tighter and tighter. At the commencement of the current cotton season, viz., September 1, 1948, mills in the Indian Union held 1,380,000 bales of Indian Union and Pakistan cottons and 200,000 bales of other foreign cotton. The stocks with the trade (other than spinning mills) on the same date were estimated to be about 1,150,000 bales of all cotton. The crop during the current season is not likely to exceed 2,500,000 bales. Of this, 270,000 bales would be utilized for extra-factory consumption. Even assuming that about 650,000 bales of Pakistan cotton would be received during the current season in addition to the usual import of about 600,000 bales of other foreign cotton (*i.e.*, cotton from Egypt, Sudan, East Africa and U.S.A.), the total supply of cotton available would be some 6,480,000 bales. Assuming also that the mill consumption will go on at the same rate as in the previous season and amount to 4,210,000 bales and that the exports will be 300,000 bales and extra-factory consumption 270,000 bales, the total offtake during the season would be about 4,780,000 bales, leaving a carryover of 1,700,000 bales of cotton with the mills and the trade at the end of the current season, against the opening carryover of 2,730,000 bales in the previous year. This means a reduction of over 1,000,000 bales. Assuming a carryover of cotton with the mills on August 31, 1949, at the same level as on the corresponding date of the previous year, the stocks of cotton with the trade in the Indian Union at the end of the current season would be negligible. The Indian Union is thus faced with a serious shortage of cotton. The position can only be met by one or more of the following three ways:

(i) larger imports from abroad,
(ii) increased production within the country or
(iii) curtailment of consumption.

Each one these measures has its difficulties and repercussions on the entire economy of the country. A satisfactory solution seems difficult to look for at present.

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COTTON IN ETHIOPIA AND THE SOMALILANDS

BY

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Somalia occasionally reaches the newspapers when the future of the Italian colonies is under discussion, but it is perhaps also of some topical interest as a modest potential source of long-staple cotton outside the Nile Valley. And the "horn of Africa" is not without other points of interest concerning cotton. Two of the four wild lintless species of *Gossypium* which are indigenous in Africa are found in the Somalilands (*somalense* and *stocksii*). Of present-day cultivated cottons, *G. arboreum* occurs in British Somaliland, and may well date back to the earliest introduction of true cotton to Africa; it was probably this species which reached the Nile valley from India, most likely by way of Arabia, and gave rise to the first African cotton trade in about the fifth century B.C.[16] Some two thousand years later came *G. hirsutum* from the New World, probably first represented by the drought-resistant variety *punctatum*, which is still to be found in Hargeisa and other settlements of British Somaliland. Egyptian strains of *G. barbadense* were introduced into Somalia a mere twenty-five years ago, for irrigated cultivation along the Webbe Shibeli and Juba rivers; and modern Upland strains of *G. hirsutum*, from the United States, the Belgian Congo and South Africa, were introduced into Ethiopia during the recent Italian occupation.

In Ethiopia four vegetation zones are commonly recognized: the *Quolla*, predominantly thorn bush, below 5,000-6,000 ft.; the *Woina-Dega*, characterized by evergreen trees and shrubs with Mediterranean affinities, from 5,000-6,000 ft. to about 8,000 ft.; the *Dega*, grassland between about 8,000 and 11,000 ft., with *Protea* providing a link with the Cape flora; and the *Urec*, above 11,000 ft.[8] Cotton has long been cultivated in the *Quolla* and the lower parts of the *Woina-Dega*, and spun and woven by the local women into coarse but serviceable fabrics. During the Italian occupation a substantial expansion of rain-grown Upland cultivation was attempted, primarily in the interests of the Italian mills, and "cotton districts" with ginneries were established by the *Compagnia Nazionale per il Cotone di Etiopia*, at Adama and Soddu along the Rift Valley, at Alomata in the north, and at Nakamti, towards the "Sudan slope." Besides fostering direct production on Italian-owned estates, the *Compagnia* endeavoured to stimulate native

cotton cultivation, and bilingual handbooks[7] extolled in Amharic, Italian and simple pictures such practices as deep cultivation and thorough weeding.

Adama, 66 miles south-east of Addis Ababa on the Jibuti railway and 5,600 ft. above sea-level, was the centre of the Awash valley cotton district. The ginnery, completed in 1939, was equipped with a 120-h.p. Tosa 5-cylinder Diesel engine, Continental 80-saw gins and delinters, and Velghe hydraulic presses, with a capacity of up to 6 tons of seed cotton per day. Cotton was usually planted in June-July, at the beginning of the long rains, and picked in December-January; in some seasons it was also possible to plant an early crop on the short rains in April, picking in October. American Upland strains were grown, chiefly Acala, as elsewhere in Ethiopia, with some Cliett and Bagley; Stoneville and Delfos gave good quality but poor yields. The 1940-41 crop, seen still on the land in June, 1941, was said to have given about 100 tons of lint for the district, with yields of about 150 lb. per acre, considered to have been reduced by shortage of rain.

Soddu, 190 miles south of Addis Ababa and 6,900 ft. up, served the cotton-growing areas of Lake Margherita (Abaya), 4,200 ft. above sea-level, and the valley of the Billate river flowing into it. U.4 strains, supplied from Barberton in 1937 through the *Istituto Agricolo Coloniale Italiano*, were stated (before the writer's connection with Barberton was mentioned!) to have given excellent results in this area on account of their improved jassid resistance. Sorghums, sugar-cane and bananas are also grown in the area.

Further south along the Rift Valley, in the pagan Gardulla and Conso areas south of Lake Chamo (4,000 ft. above sea-level), native cotton cultivation had long been established, with a well-developed peasant weaving industry. Other crops grown include maize, barley, finger-millet, dura and tobacco.

Alomata, 370 miles north of Addis on the Asmara road, served the cotton cultivation of the plain of Kobbo, 4,500-5,000 ft. up at the foot of the main eastern escarpment, which here rises to 10,000-12,000 ft. Dura and maize are also grown by the predominantly Moslem population of the plain.

Nakamti (Lechemti) served the Didessa valley, 250 miles west of Addis at an altitude of 4,000-5,000 ft. The Didessa river, a tributary of the Blue Nile, drains part of the wettest area of Ethiopia, between Gore and Gimma, with a rainfall of more than 70 inches. Nakamti was regarded as perhaps the most promising of the four Ethiopian cotton districts; it has a rainfall of something like 50 inches, compared with 20-40 inches in the other three.[11]

Dembidollo, 190 miles west of Nakamti, was regarded as a potential centre for cotton cultivation in the upper Sobat basin. Cotton was grown

in the Birbir valley, north-east of Dembidollo at 3,000-5,000 ft., and lower down, in the Iambo region to the south, together with dura, maize, tobacco, beans, rice, castor-oil and sesame, by the Anuak, an eastern branch of the Shilluk tribe of the Sudan. Another centre considered in connection with the development of cotton cultivation on the Sudan slope was Metemma, further north, just across the frontier from Gallabat in the Sudan and at an altitude of 2,500 ft.

During the Italian occupation a spinning and weaving mill was erected at Diredawa, but obtained only a fraction of its requirements locally, importing raw cotton from India, Iran and elsewhere.[17] Its maximum daily output of 9,000 metres of good quality unbleached cloth was said to be only one-fifth of the country's consumption—which provides some indication of the scope for expanding local production; about 7,500 tons of cotton, raw and piece goods, were imported annually into Ethiopia before the Italian occupation. The requirements of the Italian mills subsequently became the primary consideration; cotton to the (nominal) value of 6·2 million lire was exported to Italy from Italian East Africa in 1937, ranking fourth among exports after hides, bananas, and coffee;[8] and 900 tons of cotton were exported from Ethiopia to Italy in 1938[3]—representing less than 1 per cent. of Italian requirements.[2]

Jassids (*Empoasca* spp.) were regarded as the most serious cotton pests in Ethiopia, and the jassid resistance of the U.4 strains was accordingly considered of particular importance. The capsid *Helopeltis* also causes damage.[7] Cotton stainers—*Dysdercus cardinalis* Gerst., *D. nigrofasciatus* Stal and *D. superstitiosus* Fab.[12, 22]—occur, though apparently often without serious *Nematospora*. Ethiopia is periodically invaded by swarms of the Desert Locust and the African Migratory Locust; and pink, red, American and spiny bollworms, Egyptian cotton-worm and cotton seed-bugs were stated to occur in Italian East Africa generally.

Within 60 miles east of Soddu, across the Rift Valley, are the head-waters of both the Webbe Shibeli and the Juba, the two great rivers of Somalia.

The Webbe Shibeli, 1,500 miles long, was first discovered little more than a hundred years ago. It drains parts of the Arussi highlands with an annual rainfall of more than 60 inches, but much of its 80,000 square mile basin is hot and dry, with a rainfall of less than 8 inches in some areas, and the salinity of the river is high, particularly during the floods. After emerging from the Ethiopian foothills, the volume of the river gradually decreases by evaporation as it traverses the arid interior of Somalia, giving a mean annual flow in its lower course of about 70 cubic metres per second,[8] less than half the minimum flow of the Blue Nile. The Webbe Shibeli is finally diverted south-westwards by the

coastal dunes, and terminates in the Balli swamp, not far short of the mouth of the Juba. Somalia has two brief wet seasons, known respectively as *Gu* and *Der*, at the change-over of the monsoons in March-May and October-November, with two corresponding annual floods of the Webbe Shibeli. The main flood, when the river rises some 20 ft., carrying much red mud, begins at the end of March, and lasts about four months. The second flood, which is somewhat lower, begins early in September, lasts one to two months, and then falls rapidly, the lower reaches of the river drying up completely.

Native Upland cultivation, on the middle Webbe Shibeli, around Belet Wen and Callafo, 200-350 miles north of Mogadishu and 500-800 ft. above sea-level, and on the upper Juba, appears to have provided more than half Somalia's total cotton production of some 2,500 tons annually, but the production of Egyptian strains on the irrigated Italian concessions lower down is perhaps of more topical interest. The farthest upstream of these irrigation schemes on the Webbe Shibeli is 56 miles north of Mogadishu and 360 ft. above sea-level, at Villaggio Duca degli Abruzzi, named after the founder of the *Societa Agricola Italo-Somala.* The earth dam, which controls the flow of nearly 70 miles of the river, was completed in 1923, and by 1935 was irrigating some 10,000 acres of the S.A.I.S. concession, of which about 3,000 were cotton, a similar area maize (two crops a year) and other food-crops, and about 1,600 acres sugar-cane. The ginnery, near Villaggio, had a capacity of 30 bales a day. The sugar went before the war to the State-provided Italian market, while for local consumption it was found cheaper to import sugar into Somalia from Yugoslavia. Since the British occupation S.A.I.S. has been switched over almost entirely to sugar-cane, and now provides the whole of the sugar required by the territory, while the associated distillery likewise continues to minister to the morale of those who work in Somalia. The cane mill has been kept in operation by its Italian engineers by improvising spares from such material as ships' propeller-shafts, in the same spirit that the great 10-ton Diesel trucks which are Somalia's main means of heavy transport have been kept on the road by their Italian mechanics by such expedients as building up composite spare tyres by *bolting* together sound sections from burst ones.

Downstream from Villaggio is Afgoi, 18 miles west of Mogadishu and 280 ft. above sea-level, with a pump scheme and 5,000 acres of cultivation, of which about 1,000 were formerly under cotton. Since the occupation the Afgoi holdings have concentrated on fresh vegetables for Mogadishu.

Below Afgoi is Genale, 70 miles south-west of Mogadishu and 230 ft. above sea-level, where the Webbe Shibeli approaches to within 8 miles of the sea. Experimental agriculture in Somalia began here in 1912; the

dam was completed in 1926, and irrigates a total area of about 60,000 acres. Some 12,000 acres of cotton were grown before the war; the crop was handled by a ginnery at Vittorio d'Africa, between Genale and Merka, equipped with Platt roller gins capable of a daily output of 7 tons of lint.[1] The most important crop, however, was bananas, of which Genale provided almost the entire Italian supply. The type grown is the "Juba banana," a variety of *Musa cavendishii* which is well adapted to the relatively dry atmosphere and strong winds and also travels satisfactorily. More than 100,000 tons were exported annually through the port of Merka, 17 miles away. Since the occupation 12,000 acres of maize, sesame, ground-nuts, and beans at Genale have provided a useful contribution to the territory's food-supplies.

At Avai, about 160 ft. above sea-level, 100 miles south-west of Genale and some 20 miles above the beginning of the Balli swamp, are two more concessions comprising together some 1,200 acres of cultivation, which formerly included about 100 acres of cotton.

The Juba is an impressive river, just over 1,000 miles in length; before the war it was navigated for more than half the year by leisurely wood-burning river-steamer from Giumbo at the mouth to Bardera, 330 miles upstream and 380 ft. above sea-level. It arises by the confluence of the Dawa Parma, the Ganale Dorya and the Web Gestro, between them draining some 50,000 square miles of the southern Ethiopian highlands, and its middle and lower course is not subjected to such intense evaporation as that of the Webbe Shibeli. The Juba is lowest during the first three months of the year, with a minimum flow at Bardera of about 100 cubic metres per second. The first flood usually begins in April, when the river may rise more than 6 ft. in twenty-four hours at Bardera, and subsides from July onwards. The second flood lasts from about October until mid-December, with a rise of up to 20 ft. at Bardera and a maximum flow of about 1,000 metres cube a second; a dam at the Arriento rapids, 20 miles above Bardera, would irrigate a vast area.[8] Irrigated cultivation, to the extent of some 25,000 acres, including before the war about 2,500 acres of cotton, has so far been largely confined to the lowest 100 miles of the valley, with an agricultural station at Alessandra, 80 miles above Giumbo, and a ginnery at Belet Amin, lower down. There was also native-grown cotton and tobacco on floodland as far up as Dujuma, 180 miles from the sea. Since the occupation the Juba concessions have provided about 6,000 acres of food crops.

There was said to be a compulsory close season at Villaggio, Genale and on the Juba from February, and cotton was planted on the *Gu* flood in April-May. The type grown was Sakel, as also at Tessenei on the Gash in Eritrea. New seed was normally available each season, though some Villaggio-grown Sakellaridis seed ("Scassel") was used in addition, and X.1730 from the Sudan was also grown. Some 5 tons of

cotton were grown as recently as 1946 to maintain local seed stocks. At Genale a spacing of 1 m. × 40 cm. was used, with 4-5 seeds per hole, requiring a sowing rate of about 30 lb. per acre. The seedlings were thinned to 2 per hole, giving 5 plants per square metre, as is usual in the Sudan Gezira, compared with an average of about 13 in the Nile Delta where earliness is important.[9] 1,000-1,500 cubic metres of water were applied per hectare at the first and second irrigations, about 800 at the third and fourth, and a fifth was sometimes given, compared with the usual 14 irrigations totalling about 14,000 cubic metres per hectare in the Gezira.[14] The crop was normally cultivated four times. Picking took place between October and February. Improved yields had been obtained from experimental *Der* plantings at Afgoi in October, with picking from the end of February until early April. Similar results were obtained at Villaggio, and a September planting date has subsequently been suggested, in order to have the cotton crop finished in time for the preparation of the land for the *Gu* season.

Such yield data as are available provide an interesting comparison with corresponding figures from Egypt and the Sudan. Mean yields at Villaggio in 1930 and 1931, from some 1,500 hectares, were respectively 2·14 and 4·30 quintals lint per hectare.[20] A few years later the usual Villaggio crop was stated[8] to be about 7,000 quintals seed cotton from 1,200 hectares, with a ginning out-turn of 34 per cent., corresponding to a mean yield of 2·0 quintals lint per hectare. Signor U. Mortara, an agronomist with a number of years' experience of the pre-war Genale crop, gave the writer up to 3 quintals per hectare as a representative figure for Villaggio, which was regarded as the best of the cotton-growing areas in the territory; this level was also reached by the *Der* plantings at Afgoi. Mortara quoted 1 quintal per hectare as representative of the Genale and Juba crops, in fair agreement with published mean yields of 0·93 and 0·63 quintals lint per hectare for Genale in the 1930 and 1934-35 seasons respectively.[1, 20] Over the period 1930-38 the average yields of the entire commercial crops of the Sudan Gezira and the Nile Delta, both also largely Sakel, were respectively 3·45 and 3·90 kantars seed-cotton per feddan,[9] equivalent to some 4 and 4½ quintals lint per hectare. The Villaggio yield reached this standard in 1931, but it seems unlikely that its general level over a number of years can have much more than half the average Egyptian and Sudan yields; and the Genale level is likely to have been still lower. Yet climatically the cotton-growing areas of Somalia differ much less from the Gezira than does the Nile Delta. Thus the mean temperatures over the six months from sowing until the beginning of picking (April-September) are 80° F. at Villaggio and at Afgoi and 82° F. at Giumbo, compared with 81° for the corresponding period (August-January) in the Gezira (Wad Medani) and 73° for March-August at Qorashia in the Delta; and Villaggio, Afgoi, and

Giumbo have equinoctial rains with respective annual totals of 20 inches, 19 inches and 16 inches, compared with a summer rainfall of 16 inches at Wad Medani and a winter rainfall of 2½ inches at Qorashia.[9, 10] Again, the Villaggio soil, like that of the Gezira,[14] is a deep, heavy, alkaline clay, low in organic matter and humus, generally impermeable and hence undrainable.[20] There is, however, a considerable difference in the irrigation water, that of the Webbe Shibeli containing in particular 11 to 40 parts per million of chlorides,[20] with the higher values during the floods, compared with the Blue Nile average of 2·4;[14] and it has in fact been concluded that the shortcomings of the Webbe Shibeli cotton crop, associated with a characteristic leaf-crinkle previously attributed to jassid,[18] were primarily due to a physiological disorder resulting from high concentrations of salts in the soil water.[20] The difficulties of irrigated cotton cultivation on the Webbe Shibeli thus provide perhaps some indication of what the Gezira has owed to the quality of the Blue Nile water. Attention was drawn[20] to the importance in these circumstances of light irrigation (and pre-war Genale practice gave in fact about one-third of the water received by the Gezira crop), and of fallow (already demonstrated in native cultivation along the river), which amounted to less than a tenth of the cultivated area at Villaggio[8] compared with approximately half in the present Gezira rotation.

Pink bollworm (*Platyedra gossypiella* Saund.) was considered the most serious of the insect pests of cotton in Somalia. As elsewhere in the equatorial zone, diapause does not occur, all stages being present throughout the year. Seed treatment is accordingly of little use,[6] pupation normally occurring elsewhere, often in the soil. While the survival of the insect is thus dependent on a continuous succession of short-term generations, the presence of wild host-plants—*Thespesia*, *Hibiscus*, *Abutilon*[19]—and perhaps of native cultivation is likely to have reduced the potential effectiveness of the close season. The larvæ are attacked by *Microbracon kirkpatricki* Wlkn. as in Kenya, and by three other species of parasite of lesser importance.[21]

Red bollworm (*Diparopsis castanea* Hmps.) is also reported to occur throughout the year,[5] and thus may similarly have no resting stage in Somalia. American bollworm (*Heliothis armigera* Hb.), also regarded as an important pest, is parasitized by *Apanteles* sp. and by the Tachinids *Sturmia inconspicua* Mg. and *Gonia bimaculata* Wd.,[4, 21] as at Barberton.

Serious root damage by the larvæ of *Syagrus rugiceps* Lef., often killing full-grown plants, has been recorded, together with leaf damage by the adult beetles.[4] Elsewhere serious attack by this genus provides a sensitive indicator of continuous cotton cultivation, which was in fact not uncommon in Somalia, though at Villaggio cotton was generally grown in a rotation, following sugar-cane. Root damage was also caused by chafer-grubs of the genus *Schizonycha*.[5]

Cotton stainers—virtually absent from the Gezira—were among the most serious pests of cotton in Somalia, necessitating for example hand-collection at Genale, though, as often noted in other territories, the initial immigration into cotton was usually too late to affect the first picking. The chief species was *Dysdercus cardinalis* Gerst., occurring also on the local *Hibiscus*.[5] *D. festivus* Gerst. has also been recorded from the territory,[12] as has *D. scasselatii* Del Guer., variously regarded as probably only a form of *D. fasciatus* Sign.,[22] or not a *Dysdercus* at all.[12] *D. fasciatus* occurs across the border in Kenya, and both of its usual arboreal host genera extend into Somalia; baobab is common in the lower valley of both Tana and Juba and extends as far north as Genale, while the gallery forest along the Somalia rivers also includes *Thespesia danis*. Cotton is simarly attacked by three species of *Nezara*.

Jassids (*Empoasca dolichi* Paoli, *E. facialis* Jac., *E. lybica* Berg. and *Erythroneura lubicæ* China) cause damage, particularly, as elsewhere, to plants already in physiological difficulties. They are attacked by the Mymarid egg-parasite *Anagrus scasselatis* Paoli.[18]

Other cotton pests recorded from Somalia[15, etc.] include false codling moth *Argyroploce leucotreta*, Meyr., the "red bollworm" of Uganda), spiny bollworms (*Earias* spp.), the cotton seed-bug (*Oxycarenus hyalinipennis*, Costa), whitefly (*Bemisia tabaci*, Genn.), flea-beetle (*Phyllotreta tenuimarginata*, Jac.), stemborers (*Sphenoptera* spp.), the Egyptian cotton-worm (*Prodenia litura*, F.) and half a dozen other species of leaf-feeding caterpillars; two species of aphids and four of thrips; termites, crickets and grasshoppers. Bacterial blight-*Xanthomonas malvacearum* (E. F. Sm.) Dowson—also occurs,[20] and the territory is subject to heavy invasions by the Desert Locust.

The future of the irrigation schemes of Somalia, like that of the whole territory, is uncertain, and derelict lands on the lower Juba in 1947 provided a depressing contrast with the crops of Sakel and mealies which they had carried in 1941. The biggest immediate problem is shortage of labour, which is partly a natural result of a pre-war system of at times virtually forced labour—associated perhaps with the substantial military garrisons, replaced by the British administration on a basis at times of literally a platoon for a brigade. Natural difficulties, in addition to the problems already mentioned, include malaria, for which Villaggio and Genale are somewhat notorious, and tsetse, which has restricted the use of Somalia oxen at Villaggio. It has been estimated that the bananas and cotton of Somalia were in fact sold in Italy at four and twelve times the respective world prices;[13] and the growers were dissatisfied with the price obtained in the open market even in 1946 for some 350 tons of cotton which had been in store since the occupation. However, the excessive production costs were at least partly due to the heavy superstructure of political appointments

superimposed on the original schemes, which may well have been fundamentally sound. Since the occupation, these schemes, though operating only at half capacity, have helped Somalia to become practically self-supporting in foodstuffs.[13] Even during the East African shortage of 1943, its supplies of grain proved almost equal to the situation. The balance was made up by imports from Ethiopia, and it was not necessary to make any demands on shipping space for help. The natural difficulties of the irrigation schemes are not insuperable; and, while the Somalis themselves show all the traditional distaste of the nomad for settled farming, the agricultural skill of the Bantu riverine tribes, such as the Wagosha of the Juba valley, may prove an important factor in the eventual development of these areas.

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DEVELOPMENTS IN THE WORLD RAW COTTON SITUATION DURING THE 1948-49 SEASON

BY

DUDLEY WINDEL

ON THE basis of the latest available statistical information, world production of commercial raw cotton this season will exceed world consumption by approximately 850,000 bales, increasing the end-season carryover to around 14,704,000 bales. This is the first seasonal increase in the world carryover since the termination of the last war, and reflects the steady recovery in the volume of world-production over the past four years, particularly in the United States.

SUPPLY AND DISTRIBUTION OF ALL COMMERCIAL COTTON IN THE WORLD*

AMERICAN IN RUNNING BALES; OTHER COTTONS IN EQUIVALENT 478 LB. NET BALES (000's OMITTED)

Season.	*Carryover August* 1	*Production*	*Total Supply*	*Consumption*	*Destroyed*	*Carryover July* 31
1936-37	13,649	30,729	44,378	30,638	45	13,695
1937-38	13,695	36,745	50,440	27,573	165	22,702
1938-39	22,702	27,509	50,211	28,507	66	21-638
1939-40	21,638	27,326	48,964	28,496	206	20,262
1940-41	20,262	28,720	48,982	26,595	220	22,167
1941-42	22,167	25,616	47,783	25,033	165	22,585
1942-43	22,585	25,582	48,167	24,293	304	23,570
1943-44	23,570	24,521	48,091	22,566	121	25,404
1944-45	25,404	23,631	49,035	22,204	233	26,598
1945-46	26,598	19,890	46,488	23,110	337	23,041
1946-47	23,041	20,279	43,320	25,893	205	17,222
1947-48	17,546	23,489	41,035	26,975	230	13,830
1948-49	13,830	27,024	40,854	25,950	200	14,704

World production this season, although exceeding the 1947-48 output by around 3,500,000 bales, did not come up to earlier expectations as the bumper U.S.A. harvest was offset by smaller crops than anticipated in India, Pakistan and Russia.

World consumption during the current season has also fallen below expectations, due mainly to a sharp curtailment of mill operations in the United States. Consumption in Continental Europe, Asia and South America has been maintained at close to last season's levels, small increases in some countries offsetting decreases in others.

* Source: New York Cotton Exchange to 1946-47. Writer's estimates 1947-48 and 1948-49.

The attainment of a reasonable balance between world supply and demand has been reflected in an easier tendency in raw cotton prices from the abnormally high levels reached in 1948. Indications are that the postwar inflation in prices of primary products generally has fully run its course, and that with the steady recovery in world agricultural and industrial productivity a period of readjustment now lies ahead.

WORLD CARRYOVER AND PRODUCTION OF COMMERCIAL COTTON IN THE WORLD*

AMERICAN IN RUNNING BALES; FOREIGN IN EQUIVALENT 478 LB. NET BALES (000'S OMITTED)

World Stocks, July 31, 1948.

U.S.A.	3,100
Canada	150
Mexico	90
Other N. America	25
Brazil	1,170
Argentina	310
Peru	130
Other S. America	115
U.K.	1,360
France	285
Italy	325
Russia	500
Germany (all zones)	130
Holland	90
Belgium	150
Switzerland	100
Sweden	75
Spain	110
Czechoslovakia	70
Yugoslavia	30
Poland	130
Other Continent	160
India	2,000
Pakistan	100
China	750
Japan	235
Other Asia	220
Egypt	900
Belgian Congo	100
Other Africa	340
Australia, etc.	80
Afloat	500
	13,830

World Production, 1948-49.

U.S.A.	14,540
Mexico	560
Other N. America	40
Brazil	1,430
Argentina	460
Peru	330
Other S. America	95
Europe	150
Russia	2,500
Turkey	235
Persia	100
India	1,900
Pakistan	870
China	750
Burma	36
Other Asia	145
Egypt	1,775
Belgian Congo	190
British East Africa	355
Nigeria	38
French Africa	115
Portuguese Africa	110
Sudan	250
Other Africa	20
Elsewhere	30
	27,024

The increase in 1948-49 world production of around 3,540,000 bales was due very largely to an expansion of 2,940,000 bales in the U.S.A. crop and of 461,000 bales in the Egyptian crop. Moderate increases

* Revised.

in Mexico, Brazil, Argentina and African countries were about offset by decreases in India and Russia.

WORLD CONSUMPTION OF COMMERCIAL COTTON AND PROSPECTIVE CARRYOVER

AMERICAN IN RUNNING BALES; FOREIGN IN EQUIVALENT 478 LB. NET BALES (000's OMITTED)

World Consumption, 1948-49*

U.S.A.	7,700
Canada	410
Mexico	230
Other North America	70
United Kingdom	2,050
France	1,050
Germany (all zones)	850
Italy	900
Belgium	370
Czechoslovakia	240
Holland	250
Poland	370
Spain	300
Switzerland	120
Portugal	150
Sweden	125
Hungary	130
Austria	105
Greece	85
Denmark	45
Yugoslavia	70
Other Europe	150
Russia	2,200
India	3,500
Pakistan	100
Japan	700
China	1,400
Other Asia	450
Brazil	800
Argentina	400
Peru	70
Other South America	210
Africa, Australasia, etc.	350
	25,950

World Stocks, July 31, 1949*

U.S.A.	5,700
Canada	130
Mexico	150
Other North America	20
Brazil	700
Argentina	350
Peru	150
Other South America	110
United Kingdom	1,400
France	300
Italy	400
Russia	450
Germany	200
Holland	100
Belgium	130
Switzerland	80
Sweden	80
Spain	60
Czechoslovakia	90
Yugoslavia	30
Poland	150
Other Continent	150
India	1,100
Pakistan	124
China	350
Japan	200
Other Asia	250
Egypt	750
Belgian Congo	100
Other Africa	350
Australia, etc.	50
Afloat	500
	14,704

The tentative estimate of world carryover of raw cotton on July 31, 1949, shows that, compared with a year previous, stocks in the U.S.A. will be increased by nearly 3,000,000 bales. On the other hand, there will be large decreases in India and Brazil, and a moderate reduction in Egypt. Stocks on the European Continent in the aggregate do not appear likely to show any important change in the season.

The feature in the world consumption table for the present season is the sharp contraction of over 1,600,000 bales in the United States figure

* Tentative estimates.

compared with the 1947-48 season. Elsewhere in the world, consumption has apparently held more or less stable over the past year, except for small increases in Germany, the United Kingdom and Japan.

Fuller details of production in the various producing countries this season are summarized below:

WORLD RAW COTTON PRODUCTION IN 1948-49.

NORTH AMERICA

United States.—The acreage under cultivation on July 1, 1948, totalled 23,110,000 acres—7½ per cent. more than the 1947 acreage of 21,500,000, and about 1 per cent. below the 1937-46 average. The growing season was predominantly favourable and the average yield of 313·1 lb. per acre was the highest on record, comparing with 267·3 lb. in 1947 and the ten-year average of 254·2 lb. The unusually high yield in 1948 was not only due to the exceptionally good growing season but also to heavier fertilization and to a larger proportion of the acreage being planted in the higher yielding areas, such as California. The total harvest at 14,540,000 running bales, compared with 11,552,000 bales in the 1947-48 season and was the largest gathered in any year since 1937-38.

Mexico.—The area under cotton cultivation was increased by about 8 per cent. compared with the previous season and with good growing weather a crop of 560,000 bales was harvested, compared with 490,000 bales in 1947-48.

SOUTH AMERICA

Brazil.—The 1948 planted acreage in the Northern States was slightly larger than that for the previous season, but the crop was adversely affected both in quantity and quality by a wet summer, and the final yield was only 426,750 bales (478 lb.), as against 512,500 bales in 1947.

Acreage sown to cotton in South Brazil last autumn was nearly a third larger than a year previous. The growing period turned out generally satisfactory, though rains at picking time lowered the average quality of the crop considerably. The Southern harvest is estimated at around 1,000,000 bales (478 lb.), or approximately 300,000 bales more than the poor 1947-48 outturn.

Peru.—Acreage planted to cotton this season showed no important change. Growing conditions have been normally favourable in most of the valleys, and a yield of 280,000 bales (478 lb.) of Tanguis and about 50,000 bales of Pima is anticipated—a moderate increase on 1947-48.

Argentina.—The area placed under cotton last autumn was around 15 per cent. larger than a year previous. The growing season was very good until harvesting time, when rains severely reduced the grade of

open cotton. Lack of pickers was also a serious problem. The harvest is provisionally estimated at around 460,000 bales (478 lb.)—an increase of around 100,000 bales on the very disappointing 1947-48 crop.

AFRICA

Egypt.—The 1948-49 cotton acreage is officially estimated at 1,440,809 feddans, compared with 1,254,154 feddans in 1947-48. Weather conditions were generally satisfactory and a crop of 1,775,000 bales (478 lb.) was realized as against 1,314,000 bales in the previous season. The increased production was largely composed of Ashmouni, Karnak, Menoufi and Giza 30 varieties, partly at the expense of Giza 7 and Zagora.

Sudan.—The area planted to cotton this season was 387,533 feddans—an increase of 37,428 feddans on 1947-48. The crop is officially estimated at 250,000 bales (478 lb.), as against 216,000 bales in 1947-48.

British East Africa.—The 1948-49 growing season in Uganda was unusually favourable and with the acreage about 50 per cent. larger, a harvest of around 310,000 bales (478 lb.) was attained, or slightly more than double the 1947-48 production. The Tanganyika cotton crop, however, at 42,000 bales (478 lb.) was little changed from the previous year's outturn.

Belgian Congo.—Both acreage and production are keeping almost constant from season to season. The 1948-49 yield is again estimated at 190,000 bales (478 lb.).

Nigeria.—Higher prices offered to native growers stimulated larger plantings, and the current season's crop is estimated at 38,000 bales (478 lb.)—or about 20 per cent. above the yield for the previous season.

French Colonial Africa.—Production in French Oriental and Equatorial Africa averages close to 24,000 metric tons annually, or the equivalent of around 115,000 bales (478 lb.).

Portuguese Colonial Africa.—Adverse weather and heavy insect damage adversely affected the 1948-49 cotton crops in Mozambique and Angola, reducing the harvest to around 110,000 bales (478 lb.) and considerably lowering the average quality.

EUROPE

Continent.—The 1948-49 aggregate European production is estimated at 150,000 bales (478 lb.)—only a small increase on 1947-48 and due mainly to a moderately higher yield in Spain and Roumania. Production in Greece, Bulgaria and Italy appears little changed.

ASIA

Russia.—No official information is available on the acreage and production in the U.S.S.R. this season, but, according to private advices, the harvest was disappointing and only about 2,500,000 bales (478 lb.).

Turkey.—The 1948-49 cotton acreage was increased by 25 to 30 per cent. compared with the 1947-48 area. The crop is officially estimated at 235,000 bales (478 lb.).

Pakistan.—Acreage planted to cotton in 1948 is believed to have been slightly larger than in the previous year. Floods and indifferent cultivation, however, resulted in disappointing yields in the West Punjab, and the estimated total crop at 870,000 bales was about 200,000 bales below early expectations. The average quality of the crop suffered from inexperienced ginning and the practice of mixing in short stapled cotton with the American-seed varieties.

India.—Approximately 11,500,000 acres were planted to cotton for the 1948-49 season—an increase of about 5 per cent. on the 1947-48 area. Excessive rains in the Oomra, Jarilla and East Bengal districts and cyclone damage in the Bombay Province reduced the total harvest to around 2,300,000 bales—or 1,900,000 equivalent 478 lb. bales.

China.—The 1948-49 cotton crop is unofficially estimated at 2,100,000 bales (478 lb.), but owing to the Communist invasion of the cotton-growing areas and the active hostilities, only about 700,000 bales reached the coastal and other mills up to the end of April. However, following the collapse of the Nationalist resistance in May, and the Communist occupation of the Shanghai mill districts, the delivery of cotton from the interior may shortly be resumed on a much freer scale.

PROSPECTS FOR THE 1949-50 SEASON

As a result of the good prices received from last season's crops, cotton growers in most countries have planted or intend to plant still larger acreages for the coming season.

In the United States, it is believed that around 26,500,000 acres have been sown to cotton—or around 15 per cent. more than in 1948. The Mexican acreage is reported to be 20 to 30 per cent. larger, and the Egyptian acreage 15 per cent. greater than last year's area. No important change is indicated in the Anglo-Egyptian Sudan, Uganda or other African countries, but both India and Pakistan expect to put more land under cotton than last season. It is too early to predict the size of plantings in the South American cotton-growing countries next autumn, but the probability is that the areas sown in Brazil, Argentina, Peru, etc., will at least equal the 1948-49 figures. Prospects in China are very uncertain owing to the doubtful economic consequences of the Communist victory, and the outlook in Russia is obscure due to the rigorous censorship.

Assuming average growing conditions in the various producing countries, it would seem reasonable to anticipate a 1949-50 world cotton crop of between 28,000,000 and 29,000,000 bales, compared with the estimated total of 27,024,000 bales for this season.

EMPIRE COTTON CROPS FOR THE YEARS 1938–1948

(Extracted from the Annual Report of the Empire Cotton Growing Corporation, 1949)

(In bales of 400 lbs.)

The seasons are given as covering two years (*e.g.*, 1937–1938) because in the majority of the countries named planting takes place in one calendar year and picking in the next. In a few of these countries, however (*e.g.*, Tanganyika, Cyprus, Malta and some of the West Indian Islands), the crop is harvested in the same year as that in which it is planted. In such cases the figures should read as relating to the crop grown and harvested in the *latter* of the two years at the head of the column.

COUNTRY.	1937–38.	1938–39.	1939–40.	1940–41.	1941–42.	1942–43.	1943–44.	1944–45.	1945–46.	1946–47.	1947–48.	
(1) Anglo - Egyptian Sudan	331,639	331,104	292,706	319,682	295,107	354,109	222,877	374,296	242,343	282,387	276,925	(1)
(2) Uganda	417,179	303,893	296,672	368,898	236,370	112,849	191,870	272,064	228,709	231,678	166,000	(2)
(3) Kenya	19,610	9,976	11,622	15,094	12,269	5,453	6,330	5,384	5,015	5,148	4,860	(3)
(4) Tanganyika ..	44,636	64,106	65,314	72,766	51,017	38,309	24,797	40,421	41,028	39,963	53,833	(4)
(5) Nyasaland ..	17,358	5,276	6,526	5,376	14,392	5,552	8,450	8,302	9,050	11,166	12,852	(5)
(6) N. Rhodesia ..	43	77	68	78	75	39	20	23	36	4	—	(6)
(7) S. Rhodesia ..	338	82	408	433	1,938	1,464	1,657	1,227	870	434	701	(7)
(8) Union of South Africa and Swaziland	1,132	747	2,061	1,857	854	584	664	338	340	1,113	2,709	(8)
(9) Nigeria*	31,636	24,057	50,632	73,295	36,119	32,494	24,618	15,803	36,602	34,175	21,735	(9)
(10) Gold Coast ..	4	5	6	17	20	30	137	—	168	168	305	(10)
(11) Cyprus	2,151	1,705	1,735	722	1,589	1,661	1,341	2,380	1,900	2,000	1,750	(11)
(12) Malta	26	28	27	—	—	—	—	—	—	—	—	(12)
(13) Ceylon	355	196	261	452	430	46	107	10	31	40	168	(13)
(14) Queensland ..	11,935	15,457	10,319	14,296	12,312	8,364	7,366	1,627	2,847	1,906	1,782	(14)
(15) Fiji	60	7	45	38	—	—	—	—	—	—	—	(15)
(16) West Indies ..	6,196	5,636	8,492	9,312	7,450	4,555	4,099	4,525	3,762	2,573	3,963	(16)
	884,298	762,352	746,894	882,316	669,942	565,509	494,333	726,400	572,701	612,755	547,583	

* *Exports only.*

REVIEWS

REPORT ON COTTON, WITH SPECIAL REFERENCE TO COTTON AS A CROP IN PERU. G. Edward Nicholson. (Institute of Inter-American Affairs, Washington, D.C. Mimeographed. Pp. 58.) For anyone with an interest in Peruvian cotton, its history, present position and future prospects, whether that interest be commercial, genetic, agronomic or geographical, this report provides a mine of detailed and up-to-date information. Its thoroughness is attested by the remarkably wide scope and intimacy as to detail of the list of references.

The Introduction reviews the commercial cottons of the world and relates Peruvian production to world supplies. In figures for 1944 this is given as 310 out of 25,450 thousands of bales (478 lb. net).

Part I gives a general account of the wild and cultivated cottons of the world and of their classification, mainly based on the genetical investigations of S. C. Harland and J. B. Hutchinson, whose systems have superseded the morphological classification of Watt. These systems are set out and compared, and in their light the problems of the origin and distribution of species in prehistoric and historic times are discussed in considerable detail, especially the problem of the New World 26 chromosome group. Quite apart from any special interest in Peruvian cotton, this section provides a useful and well-documented review of present-day information and opinions.

Part II describes the wild (*G. Raimondii*) and cultivated "Pais" (*G. barbadense*) Peruvian cottons and discusses the origin of Tanguis, the variety now most generally cultivated. Pais is a perennial tree cotton which formerly was the only cotton cultivated in Peru. Up to 1914 it maintained a limited and highly specialized market, at high prices, for mixed yarns used in "all-wool" knitted goods manufactured in Lancashire (!) and Massachusetts. Tanguis originated in a single plant selection from a field of Upland, yet is a perennial or semi-perennial with the bearing habit of Sea Island and the vigour of a tree cotton, capable of giving several successive crops without replanting. Harland has recognized Tanguis as a form of *G. barbadense* and attributes its origin to a residue of the older cultivations maintained as an impurity in the Upland crop, with early fruiting arising from the natural selection imposed by its situation in the early maturing Upland.

Part III, the main section of the Report, describes the cotton-growing areas in Peru and their distribution, the history of cotton growing in Peru, and the contemporary situation and some of its problems. The major areas are situated on the coastal belt, from 10 to 40 miles wide, west of the foothills of the Andes. Agriculture is based entirely on irrigation from the fifty or so rivers flowing from the mountains. The climate is mild and almost rainless under the influence of the Humboldt current.

The first impulse towards cotton export came from the Cotton Famine of the eighteen-sixties, and from then onwards new varieties have been introduced from abroad. In the present century Upland (Egipcio) and Mit Afifi were dominant until about 1920, but these have been supplanted by Tanguis (85 to 90 per cent.) and the American-

Egyptian Pima. The latter is grown in certain northern valleys where insect pests exclude any but an annual cotton.

In the long period during which Tanguis has been grown it has shown signs of admixture and degeneration and some fifteen years ago its replacement was seriously considered. More recently new strains have been made available, based on two differing systems of selection. The Genetics Department of the Experimental Station of La Molina has continued since 1932 under T. Boza Barducci the selection of strains on conventional lines begun by earlier workers, notably Professor Kidder. The Institute of Cotton Genetics, established by the National Agricultural Society in 1940 under Dr. Harland, has followed a new line of approach based on the continuous selection of a relatively small mass population of strains as opposed to single strains, with the object of raising standards in the required directions without losing the variety of genes on which adaptability to variable environments depends.

On the agronomic side the existence of conditions approaching the ideal—constant water supply, a steady climate, good soil and easy access to abundant supplies of fertilizers in the form of guano and Chilean nitrate—has resulted, human nature being what it is, in very low standards of agricultural practice. Continuous cotton cultivation, with the effects of soil degeneration offset by the indiscriminate use of quick-acting fertilizers, is the general rule. Drainage is an urgent need over wide areas to remove soluble salts brought to the surface by excessive use of water. Much land that gave excellent crops thirty years ago is now in total ruin. Insect pests and wilt disease of cotton have grown increasingly serious. There is, moreover, as in the world generally, an increased demand for food crops to meet increasing population and higher standards of living, and this is likely to develop at the expense of export crops.

On the commercial side figures are given of internal consumption of cotton in relation to exports, and of the distribution of the latter. The question is discussed of the relative importance of the European and South American markets, with their conflicting requirements as to quality. On a long view the South American market, combined with internal consumption, may offer greater stability and lead to a change of type, but this is not likely to take place so long as Europe will pay good prices for Tanguis.

Contribution à l'Étude Taxonomique et Caryologique du Genre *Gossypium* et Application à l'Amélioration du Cotonnier au Congo Belge (Contribution to the taxonomy and cytology of the genus *Gossypium*, and its application to the improvement of cotton in the Belgian Congo.) By W. Wouters. (Publications de l'Institut National pour l'Étude Agronomique du Congo Belge—Série Scientifique No. 34, 1948. Obtainable from I.N.É.A.C. at 14, rue aux Laines, Bruxelles.)

This volume of some 400 pages represents a sustained effort in documenting the literature, in systematic work on the naturally occurring cottons of the Congo, and in metrical study of the chromosomes of two species. The work was done mainly in Brussels during the late war, so that many papers published since 1940 were not available. However,

its value as a work of reference is large, apart from the original work described.

In Part I of this volume, Wouters discusses at length the systematic treatment of the genus. In his first chapter he gives a masterly summing-up of the schemes so far proposed, from Parlatore (1866) and Todaro (1877) to Harland[1] (1938) and Hutchinson and Ghose[2] (1937). Useful tables are given for cross-reference. It is unfortunate that the author had not read Silow's[3] (1944) article on racial differentiation in Asiatic cottons, or Hutchinson's recent taxonomic study in *The Evolution of Gossypium* (1947).

In Chapter II, Dr. Wouters reviews the systematic value of morphological characters, for the purpose of the classification he subsequently proposes. His observations were made on herbarium material in Brussels, and on living plants in collections, presumably in the Belgian Congo. Twenty-seven possible characters are discussed in detail: some characters whose inheritance has been shown to be genetically simple, such as leaf shape, are regarded as important, contrary to the views of many geneticists; while others such as petal spot are given a minor status. Wouters has tried to assemble means of diagnosing herbarium and living material, with the object of studying the cottons naturally occurring in Central Africa. His system may be applicable to an area such as the Congo, where the range of variability is strictly limited and the populations of most types are so small as to minimize natural crossing. In areas of high variability, and where natural crossing results in free gene exchange between related types, many of the characters he uses are inadequate for taxonomic diagnosis.

Wouters names the diploid cottons Archygossypium and the tetraploids Neogossypium. The first section contains three subsections incorporating: *stocksii, anomalum, arboreum* and *herbaceum*; the wild American diploids; and the Australian species, respectively. The two species of Asiatic cottons are each subdivided; *herbaceum* has three varieties as in Hutchinson's (1947) system, while *arboreum* has six subdivisions, one being a sub-sub-variety; the initial distinction of three varieties *typicum, nanking* and *obtusifolium* is on the basis of leaf-shape alone.

The section Neogossypium includes two cultivated species, *barbadense* and *hirsutum*, and three wild ones, *tomentosum, darwinii* and *taitense*; the last two have been reduced to varieties of the two cultivated species by Hutchinson (1947). In *barbadense* the author has made out six varieties and sub-varieties, on the distinctions naked versus fuzzy seeds, free versus united (" kidney ") seeds, and perennial versus annual habit. These are uncertain taxonomically unless taken with a complex of other characters, and it would have been as useful to describe geographical distributions in terms of gene frequencies. His treatment of *hirsutum* is more in accord with the probable evolution of the group, at least in the areas away from the Mexican centre of diversity.

Concluding the first part are some notes on geographical distribution, pointing out that there have been several waves of introduction of cottons by man into " secondary areas."

Part II consists of a discussion of the so-called indigenous cottons of the Belgian Congo, and opens with a plea for the collection of seed and herbarium material, both to increase our knowledge and to preserve

the variability and the valuable genes established by natural selection. The time is growing short, because these semi-wild cottons are getting rarer every day with the spread of cultivation.

After inspection of the Congo herbarium material in Brussels, Wouters came to the conclusion that there are no truly indigenous cottons in the Congo. *Arboreum* is not present, neither was *hirsutum* (*sensu lato*) until its introduction in recent times, and all the older naturalized cottons belong to three varieties of the single species *barbadense* and are escapes from or relics of former cultivations. Of these *vitifolium* is found through practically the whole Congo region, *peruvianum* only in the Lower Congo within 500 miles of the coast, while *brasiliense* (the kidney cotton) is limited to the eastern half of the colony. There are four possible routes of introduction: (i) up the river system, (ii) from the Sudan, (iii) from East Africa, and (iv) from Angola. By measuring lint length in the *vitifolium* specimens (method not stated; the lengths are very short compared with *vitifolium* from Nigeria) two groups are revealed, 27-28 mm. in the main north-west, west and south, and 22-24 mm. in the north-east. Wouters concludes that the former came by route (i) and the latter by route (ii). He deduces that *barbadense vitifolium* came to Lower Congo between 1725 and 1775, and via West Africa and the Sudan to North East Congo about 100 years later. *Barbadense peruvianum* has clearly come via the Congo and Angola, routes (i) and (iv), at the same epoch.

The Arab traders cultivated *barbadense* var. *brasiliense* in East Africa, and in 1863 opened their first post in the Congo; the area of records for this variety fits very well the limit reached by the Arab " colonization." The author does not mention the possibility that the " *vitifoliums* " of short staple length, discussed above, might also be Arab introductions.

Among the advantages of these *barbadense* cottons, Wouters mentions genes for disease resistance, and the roughness which is desired in the commercial Congo crop. It is unlikely that any desired improvement in roughness would be as easily obtained in *barbadense* × Upland crosses as in straight Upland material. Wouters does not give details of the disease resistance of the Congo *barbadenses*, but *G. barbadense* is in general rather particularly susceptible to most pests and diseases. All experience in other parts of Africa indicates that the Upland cottons provide a range of variation adequate for almost all breeding purposes, and that with the exception of attempts to impart very high quality to Upland material, it is better to avoid the complications involved in inter-specific crosses. The second part includes detailed notes on the herbarium specimens, several maps and a bibliography.

The volume is completed by a third part treating the phylogeny of the section Neogossypium chiefly from the point of view of chromosome morphology (caryology). Such a study can elucidate theoretical problems of the permanence of chromosome number and shape, and of the allotetraploid origin of New World cottons. Its practical value lies in knowing which crosses can give fertile hybrids, and in the possibility of producing a new range of allotetraploid forms, out of which one may be able to make useful selections. Two useful chapters review (for the first time in French) the published work on the cytology and phylogeny of the genus.

Most authors are agreed on early separation (pre-Tertiary) of an

American, an Australian and an Asio-African group, all diploid (n=13), but there was at first disagreement on whether the New World tetraploid cottons (n=26) were allo- or autopolyploid. Wouters was unfortunate in not having access to the most recent publications or he would have realized that current opinion is wholly in favour of the allopolyploid theory. The age of and relations between the New World tetraploids are uncertain, but it is assumed that the annual types have evolved (by human selection) during historical times. The "recent origin" hypothesis of Hutchinson, Silow and Stephens was only published in 1947.

The remainder of the part is devoted to a detailed description with copious tables and diagrams of the author's work on chromosome morphology in the two species *G. arboreum* and *G. hirsutum*. Root tips were grown, fixed, sectioned and stained under standard conditions, so that comparisons between them have maximum possible validity. Wouters realizes that it is an impossible task to study the satellites or the nucleolar organizers of such small chromosomes, but he has been lucky to find 11 suitable metaphase plates of *G. arboreum*, which he proceeds to draw, measure the chromosomes, and construct an idiogram showing the mean length and shape of each of the 13 chromosomes of the haploid set. Recognition of any particular chromosome depends on knowing the position of its centromere, and the author himself admits that he is not always without doubt thereon. However, by extensive use of Fisher's Analysis of Variance methods he gives statistical evidence of the *relative* constancy of the chromosomes between different cells, the variance found being used as the best possible estimate in comparing the idiogram of *arboreum* with that of *hirsutum* (direct estimation of a variance in the latter species being beyond even Dr. Wouters' powers). He concludes that there is little likelihood that *arboreum* is itself a secondary polyploid with a basic number of six or seven.

The observations and statistical treatment of *G. hirsutum* rest on a single metaphase plate, and provide no real evidence for or against the allotetraploid theory. It is doubtful if it is worth while to proceed on such lines while there are good prospects of obtaining more critical data from the study of meiosis and by the synthesis and testing (genetic and cytological) of allotetraploids between Asiatic cottons and New World wild species. However, Wouters has done a good service in warning us of the difficulties of studying mitotic chromosomes, and his final suggestion, of preserving cytological slides for the inspection of subsequent workers (after the manner of herbaria), may help to lessen the subjective element in cytology.

R. L. C.

REFERENCES

1. Harland, S. C. (1938): "A História da Evolução dos Algodões Cultivadós do Novo Mundo" (*An. Prim. Reuniao Sul-Amer. Bot. I*).
2. Hutchinson, J. B., and Ghose, R. L. M. (1937): "The Classification of the Cottons of Asia and Africa" (*Ind. J. Agr. Sci.*, vii, 2).
3. Silow, R. A. (1944): "The Genetics of Species Development in the Old World Cottons" (*J. Genetics*, xlvi).

A Handbook of Tropical Agriculture. By G. B. Masefield. (Oxford University Press: Geoffrey Cumberlege. Pp. 196. 12s. 6d.) Tropical agriculture is a subject both wide and deep, and in some respects its principles remain obscure. It is the first duty of the reviewer of a book under this title to give some indication of its scope. It should be made clear that neither the business man in London with tropical interests, nor the man on the spot, whether he be farmer, planter or agricultural officer, will find here any adequate discussion of the problems which constantly beset him. The author remarks on the absence of any attempt in English in recent times to deal comprehensively with the subject, and in the sense above referred to, it is doubtful if anyone but a German professor of the old school (if any such remain) would have the courage to make one. The author, who has had experience as an agricultural officer in Uganda, is lecturer in Colonial Agriculture at Oxford, and his modest hope that the book may be found generally useful as a reference book of simple facts and figures will probably find its primary justification in its value to his and other students.

The compression made necessary by the vastness of the subject is illustrated in the opening chapters, which deal in twenty-four pages with tropical soils and their conservation, implements and haulage, irrigation, and economics. There follows, making up the main body of the book, a list of the cultivated plants of the tropics, classified according to their uses, with accounts, mainly graded in length according to their importance, of their status and management as crops. A special point has been made of giving figures for such matters as seed-rate, planting distances and yields. That there are statements here and there which are open to question was inevitable, but in general the information supplied reaches a commendably high standard of accuracy.

The third section, dealing with pests and diseases of plants and animals, is too scrappy to serve even as an adequate introduction to this subject. The fourth and last section treats of livestock and pasture management and, being more in the nature of a connected account, is the most satisfactory part of the book.

The crop section could have aimed higher than its function for reference, if it had been arranged on a regional basis, exhibiting the crops in relation to each other and to their environment. In this way, with possibly no greater expenditure of space (though more is highly desirable), the student could have been presented with a living picture more interesting and more instructive than the present form provides.

Tables de Calcul Statistiques. By G. Parry. (Technologie Cotonnière ; Institut de Recherches du Coton et des Textiles Exotiques. Paris. 1948.) Breeding work of the Institute is primarily concerned with the length and fineness of cotton. Large numbers of halo length measurements have evidently been made by the author. Routine computations for the calculation of statistics of the resulting frequency arrays must often be conducted by untrained staff. However conscientious they may be, arithmetical errors are probably inevitable. The author considers that both the precision and ease of determination

of these elementary statistics are greatly facilitated where suitable tables are provided. Since these statistics may be estimated simply with a calculating machine, the tables have been provided primarily for those without this essential advantage.

The simplicity of the tables is illustrated by the fact that only four criteria are needed. These are the assumed mean, the sums of the deviations from this mean, the sums of squares of these deviations and finally the number of observations. Tables include (1) correction for the assumed mean, (2) correction for the sums of squares derived from the assumed mean, (3) variance with allowance for grouping, (4) the standard deviation, (5) coefficient of variation, (6) the precision of mean lint length, and (7) lint index based on ginning out-turn and weight of 100 seeds.

This large (13 in. by 13 in.) well-arranged publication will be useful to workers concerned with large numbers of frequency arrays of halo lengths. A minor fault may be found with the persistent use of the letter I for the numeral 1. No reference has been made to the derivation of these statistics. Presumably French readers are well aware of the original work of R. A. Fisher, and others in this country, on their importance in the study of small populations.

H. L. M.

Report of the Fifth Commonwealth Entomological Conference, July 22-30, 1948, London. (Commonwealth Institute of Entomology. Pp. 112. 7s. 6d.) The Fifth Commonwealth Entomological Conference was held after a lapse of thirteen years, caused by the war, and was attended by delegates and observers from nearly all the territories of the Commonwealth. Its reports form a valuable series of authoritative short reviews of several of the most prominent groups of problems in Commonwealth applied entomology.

The amount of time devoted to insecticidal matters reflects the importance of the advances made in this field since the last Conference. Dr. Galley briefly reviewed recently developed insecticides—the chlorinated hydrocarbons, in which a variety of new compounds are proving useful for specific purposes in addition to the older established DDT and benzene hexachloride; the extremely powerful, but highly toxic, phosphorus compounds; the systemic insecticides, *i.e.* those which are taken up via the roots of the plant protected; the synergists which activate and perhaps stabilize pyrethrin; and the pyrethrin × DDT hybrid molecules. Dr. Wigglesworth distinguished between three aspects of the mode of action of insecticides, namely, the way in which the poison is picked up, the mode of entry, and the manner of intervention in the vital processes. Mr. Ross described the agricultural uses and limitations of modern insecticides in Canada. Dr. Kearns reviewed the principles underlying the application of insecticides and fungicides and described developments in the two main groups of hydraulic and airflow equipment, and Dr. Berkely dealt with the application of aerosol methods to crops. Dr. Gunn spoke on the distribution of insecticides from aircraft, comparing the Porton method, whereby the differential carry of drops having a range of size is exploited to form a wide swathe, with the cloud method, in which very fine particles are created which have to be accurately aimed from low levels.

On the subject of biological control, Mr. Baird described the organization of the Commonwealth Bureau of Biological Control, which now has its headquarters in Canada, and reviews were given of the control of *Pieris rapæ* on crucifers in New Zealand and of mealybug on coffee in Kenya, and of the control of weeds by insects.

In discussions of developments in the control of pests of stored products, the importance was stressed, not only of methods, including the use and hazards of the newer insecticides, but of organization, alike in highly developed processes such as wheat shipping and in the primitive conditions of peasant crop storage.

The technique of estimating insect populations—surely fundamental to any informed attack on problems of applied entomology—was reviewed by Mr. Strickland; his paper and the subsequent discussion brought out the diversity of methods used and the difficulties in devising statistically satisfactory techniques.

The tse-tse fly problem was reviewed by Dr. Nash and control measures in West Africa, based on alteration of the vegetation, were described by him and by Dr. Morris; Mr. Mossop spoke of the success of the method of game reduction in Southern Rhodesia, and the possibilities of insecticides were debated.

In the field of locusts and grasshoppers, Dr. Uvarov gave his opinion that suppressive and defensive measures—*i.e.*, the direct destruction of swarms in either the incipient or outbreak form—though practical, are necessarily both costly and continuous palliatives. He stressed the need for a permanent and radical solution in the prevention of swarming, this requiring more fundamental work than had hitherto been possible. Discussions followed on the applicability of the phase theory to Australian conditions.

In addition to these discussions, the Conference made a number of resolutions about the activities of the Commonwealth Institute of Entomology, notably that the *Bulletin of Entomological Research* should be increased in size and price; recommendations were also made for the expansion of research work on termites, for the creation of a standing committee on the naming of insecticides, and for the organization of an African phytosanitary convention.

Finally, it was recommended that the next Conference should be held in 1953.

E. O. P.

CORRESPONDENCE

(The following letter has been received from Colonel W. R. Palmer, Chairman of the Cotton Exporters' Group, Uganda.)

COTTON EXPORTERS' GROUP,
P.O. Box 518,
KAMPALA,
UGANDA.
July 1*st*, 1949.

DEAR SIR,

I have read with interest, in the April number of the EMPIRE COTTON GROWING REVIEW, your comments on the Report of the Uganda Cotton Industry Commission, 1948.

The fundamental weaknesses of the industry are clearly and accurately analyzed, but there is one criticism of the Commission's Recommendations to which I wish to refer. When discussing the very necessary reorganization of the ginning industry, the article states:

> " They are theoretically in favour of free competition, and would prefer it to the *status quo*, but recognize that its restoration would lead to new abuses. They do not, however, adopt the logical alternative, which would be a fully planned system such as that which has operated with such efficiency in the Belgian Congo, where a district monopoly under appropriate safeguards is given to a responsible company. They would agree that the present system has the defects of both alternatives and the merits of neither. What the Commission do recommend is a bargain between the Government and the Uganda Cotton Association by which the pools would receive statutory authority for a five-year period on condition that within 12 months a detailed plan should be submitted for approval, providing for the reorganization and rationalization of the ginning industry. To the onlooker the incentive seems inadequate !"

In fairness to my colleagues on the Commission, I wish to point out that our terms of reference specifically precluded us from making any recommendations involving a change of ownership of the ginneries. We were therefore prevented from expressing any opinion on what the article calls " fully planned systems of ginning," the conspicuous efficiency of which in neighbouring cotton-producing countries was revealed in evidence given to the Commission.

As a false impression may have been created of the opinions held by the Commission, I shall be grateful if you will make these circumstances known in the next issue of your Review.

Yours faithfully,
W. ROBERT PALMER.

(So far as the Commission is concerned, the statement made in the Chairman's letter is a complete reply to the criticism in question, to which we gladly give the publicity requested. It would be interesting to know on what grounds the Commission was precluded from considering a system which has been so widely adopted.—ED.)

NOTES ON CURRENT LITERATURE

COTTON IN INDIA AND IN PAKISTAN

254. Indian Central Cotton Committee—February, 1949. (*Cott. and Genl. Econ. Rev.*, 18/2/1949.) Various research and expansion schemes for increasing the total yield of cotton in India with a view to making the Indian Dominion self-sufficient were considered by the Indian Central Cotton Committee at its meeting in Bombay. The Committee carefully considered the question of planned production of cotton in the light of its earlier recommendations to the Government of India that the acreage under cotton should be raised by four million acres. It pointed out that the situation regarding cotton supplies was getting serious and that the present cotton crop, even on the assumption that the whole of it would be available for the mills' requirements, was not sufficient for the needs. To rely on cotton imported appeared neither good policy nor good economy. The Committee suggested that the acreage diverted from cotton should be brought back under cotton, and intensive work should be undertaken immediately to extend the areas under improved cottons in the new areas; basic prices for cotton should be raised to an economic level so as to induce cotton cultivators to increase cotton acreage, and the differentials should be brought to such a level as might give an impetus to cultivators to grow medium and long staple cottons.

The Committee decided to send Dr. R. Sankaran, Professor of Agricultural Botany, Central College of Agriculture, Government of India, and Dr. S. M. Sikka, Cereal Botanist East Punjab, to undertake a tour of Egypt, the United States and South America for the collection of suitable material for breeding long staple varieties in India. The Committee also approved several schemes, including one for breeding unirrigated Cambodia cotton in Madras Province spread over five years at the cost of Rs. 62,000. Another scheme for the extension of Jarila seed distribution in Bombay Province was also approved.

255. Report on the Staple Length of the Indian Cotton Crop, 1946-47 Season. (Ind. Cent. Cott. Comm., Stat. Leaf. 1, June 1948.) This leaflet aims at classifying, according to length of staple, the estimated Indian cotton crop for the 1946-47 season. The need for revising the existing staple length groups in the light of the changes that have taken place in the character of the Indian crop in recent years has been felt for some time, and a Special Sub-Committee has been appointed by the Indian Central Cotton Committee to go into the whole matter. The Sub-Committee recommended the following classification for adoption: Superior long staple, 1 in. and above; long staple, $\frac{7}{8}$ to $\frac{31}{32}$ in.; superior medium staple, $\frac{13}{16}$ in. and $\frac{21}{32}$ in.; medium staple, below $\frac{13}{16}$ in. and above $\frac{11}{16}$ in.; short staple, $\frac{11}{16}$ in. and below. The method employed in classifying the crop into the various staple length groups mentioned above is not claimed to be scientifically accurate, but the analysis, nevertheless, gives a fair approximation of the staple length distribution and indicates the trend of cotton production in India. In the Indian Union the production of cotton stapling $\frac{7}{8}$ in. and above during 1946-47 formed 19 per cent. of the total, which is the same as in the previous season. The proportion of short-staple cotton to the total production was 31 per cent. in 1946-47 against 32 per cent. in the previous year.

256. Spinning-Tests Reports on Indian Cottons, 1947-48. By D. L. Sen. (*Tech. Circs.*, Nos. 734-738, 740, 741, 743-749, 751, 753. Ind. Cent. Cott. Comm., 1948.) The circulars contain the grader's report and spinning test results for Bijapur, 1938-48 seasons; Broach B.D.8, 1944-48 seasons; Cambodia Co.2 (Avanashi), 1945-48 seasons; Cambodia Co.3 (Salem), 1944-48 seasons; Jarila (Berar), 1944-48 seasons;

Jarila (East Khandesh), 1943-48 seasons; Jarila (West Khandesh), 1943-48 seasons; Jayawant (Bailhongal), 1944-48 seasons; Karunganni (Coimbatore), 1941-48 seasons; Navsari, 1941-48 seasons; Surat, 1942-48 seasons; Tinnevelly, 1942-48 seasons; Verum, 1941-48 seasons; Vijay, 1945-48 seasons; Wagad (Viramgam), 1944-48 seasons; Westerns (Anantapur), 1944-48 seasons.

257. TECHNOLOGICAL REPORTS ON INDIAN COTTONS, 1947-48. By D. L. Sen. (*Tech. Circs.*, Nos. 733, 739, 742, 750. Ind. Cent. Cott. Comm., 1948.) The particulars given include agricultural details, grader's report, fibre particulars, spinning test results and remarks for the following cottons:

Gaorani 6.—The 1947-48 sample is somewhat longer but coarser and weaker than its immediate predecessor, whereas its other fibre properties are practically the same. Suitable for 33's warp.

Jarila.—The 1947-48 sample is slightly shorter than its predecessor, but it has practically the same fibre-weight per inch and intrinsic strength, and contains a higher percentage of mature fibres. Suitable for 28's warp.

Jayawant (*Kumpta*).—The 1947-48 sample is longer than its immediate predecessor but resembles it practically in all other respects. Suitable for 40's warp.

V. 434 (*Akola*).—The 1947-48 sample possesses slightly higher intrinsic strength; otherwise it resembles its predecessor in all respects. Suitable for 28's warp.

258. THE VALUE OF DUPLICATE TESTS. By V. Venkataraman. (*Ind. Cott. Grwg. Rev.*, iii, 1, 1949, p. 40.) It was the practice at the Technological Laboratory, in the initial stages, to carry out spinning tests on duplicate samples of all cottons received for tests. But later on, in view of the very large number of agricultural samples sent for tests, tests on duplicate lots were confined only to the Standard cottons. An exhaustive statistical analysis of the results obtained for lea tests of duplicate lots of all Standard cottons for several seasons were made in order to get an idea of the special value of these duplicate tests, and also to find out the critical difference between the two lots beyond which the differences between them may be considered significant. In the present note, the following three sets of variations were worked out for duplicate lots of Standard cottons of the six seasons, 1927-30 and 1933-36. (1) Percentage variation in the count-strength product for the two lots based on the mean count-strength product of the two lots. (2) Percentage difference between the actual and the nominal counts based on the nominal count. (3) Percentage difference between the actual and the nominal twist based on the nominal twist.

259. IMPROVED VARIETY OF LONG STAPLE COTTON. See Abstract No. 370.

260. COTTON CULTIVATION IN CENTRAL INDIA AND RAJPUTANA. I. COTTON TRACTS AND THE CROP. By P. D. Gadkari and K. M. Simlote. (*Ind. Cott. Grwg. Rev.*, iii, 1, 1949, p. 19.) Central India and Rajputana together constitute an important cotton-growing area of the Indian Union. Under normal conditions approximately 2,000,000 acres are cultivated in these areas under cotton annually, from which about 390,000 bales of lint are produced. This entire produce, known to the Indian cotton trade as "*Central India, Oomras*" and "*Rajputana-Bengals*," is of short-staple category and represents approximately 20 per cent. of the area under this crop in the whole Union. The cotton cultivation of these two tracts is restricted mainly to four distinct climatic regions—namely, Malwa, Nimar, Mewar and Gang Canal Colony; each region having different problems regarding cotton cultivation and improvement. A description of the cultivation practices employed for the varieties grown in each region is given.

261. INDIAN COTTON CROP. (*Ind. Trade Bull.*, iv, 23, 1948, p. 32.) The following are the final estimates of acreage and yield in respect of the cotton crop of 1947-48 of the Indian Union including Hyderabad State. The area is 10,932,000 acres and the yield 2,116,000 bales. There is a decrease of 6·3 per cent. in area, and 0·4 per cent. in production as compared to last year.

262. THE COTTON CROP IN HYDERABAD STATE. By A. B. H. Khoorsid. (*Ind. Cott. Grwg. Rev.*, iii, 1, 1949, p. 27.) The state of Hyderabad holds a prominent place in Indian cotton production as one of the chief cotton-growing tracts of India.

Before the war it stood fourth in rank amongst all the provinces, producing nearly 10 per cent. of all the annual output from an area comprising about 15 per cent. of that of the entire country under the crop. The prominence of the State as a cotton-producing region is also due to the excellent quality of much of its produce—the Hyderabad *Gaorani* or *Bani* variety of cotton well known throughout India for its silky and strong fibre. Formerly it was the only variety of cotton grown in the northern and central districts of Hyderabad; but from the first quarter of the present century the short staple and more prolific types from the Central Provinces and Bombay Presidency have been gradually replacing it in some districts. As a result the crop of these districts has become mixed to such a degree as to impel the need for a botanical survey and plant improvement work. Plant improvement work on Gaorani cotton, financed by the Indian Central Cotton Committee and H.E.H. the Nizam's Government, was started in 1929 and the botanical survey in 1930. Other studies undertaken were for assessing the damage done to the cotton crop of the State by bollworms, which are the principal insect pests of the crop, and the methods of controlling them. Studies were also made on the cultivation of irrigated cotton in the Nizam Sagar area and on the extension of cotton growing to *chalka* or light, granitic origin lands of the Telingana Division of the State. Finally, the production and distribution of large quantities of the pure seed of the improved varieties bred by the Cotton Research Section of the Department of Agriculture was also taken up and is being continued. The article describes at some length the various activities and results of the cotton research work of the Department of Agriculture, H.E.H. the Nizam's Government.

263. "Patrap" Cotton for the Mathio Tract. By A. F. Patel and S. J. Patel. (*Ind. Cott. Grwg. Rev.*, ii, 3, 1948, p. 140.) The Mathio Tract comprises a small portion of Dhandhuka Taluka of Ahmedabad District and the whole of the Southern Kathiawar except the inundated areas of Junagadh and Porbandar States. The pre-war area under Mathio cotton was over one million acres, producing nearly 196,000 bales. The usual rotation followed in the Mathio tract is a three-year one—viz., Jowar or Bajri-Groundnut-Cotton. Mathio cotton is a short duration cotton maturing in about 6 months against 8 to 9 months required for other cottons grown in Gujarat; it was introduced from Khandesh. It derives from *G. arboreum* var. *neglectum*, and is a short-staple cotton capable of spinning 10's to 12's with a ginning out-turn of 31. Work on the improvement of Mathio has been centred at Amreli, Baroda State, and has resulted in the selection of an improved type named "Patrap," which is superior to Mathio in ginning out-turn, staple length and spinning value.

264. Plant Protection Service in the United Provinces. By K. B. Lal. See Abstract No. 346.

265. Locust Control in India. By H. S. Pruthi. See Abstract No. 353.

266. Indian Cotton Industry. (*Cott. and Genl. Econ. Rev.*, 25/3/49.) Due to a shortage of cotton supplies, mills in South and Central India have introduced a system of partial closure and a rotation of holidays with a view to ensuring that the loss in wages is shared by all the workers. Some of the mills are so hard pressed for cotton that they will have to close down within a couple of months. The Minister of Agriculture states that according to trade sources the cotton crop in India this year will be between 2,400,000 and 2,600,000 running bales. On the basis of the figures for the 1947-48 season, the quantity of cotton which the Indian mills will require for the present season is about 4,600,000 bales (392 lb.). Allowing for about 270,000 bales as an estimated requirement for extra-factory purposes, arrangements have been made to cover the deficit as follows: 650,000 bales from the Indo-Pakistan agreement, 200,000 bales through the efforts of the Indian Cotton Mission to East Africa, 350,000 bales from the U.S.A., Brazil, Egypt and the Sudan and 1,090,000 bales out of the 1947-48 carryover.

267. India and Pakistan: Cotton Crop Estimate. (*Cotton*, M/c., 12/3/49.) Messrs. Ralli Bros. Ltd., of London, estimate the 1948-49 Indian Dominion crop at 2,700,000 running bales as against 3,037,000 bales in the previous season. The 1948-49 Pakistan crop is given as 1,074,000 running bales, as against 1,065,000

bales. They add that the present Indian crop is one of the worst on record as regards yields and quality, due to the acreage restrictions, deterioration of seed, and very unfavourable weather. As a result of the smallness of the Indian crop, all varieties, except Bengals, Mathias and Comillas, which are still exportable, are below the probable requirements of Indian mills. The total deficit is about 1,100,000 bales. To offset this, India will probably take about 500,000 bales from Pakistan, and it is anticipated that much larger quantities of foreign cotton will have to be imported. Mill stocks which at the beginning of the season stood at 1,376,000 bales of Indian and 300,000 bales of foreign cotton will also be considerably reduced.

268. India and Pakistan: Cotton Mill Industry. (*Cotton*, M/c., 12/3/49.) According to the Bombay Millowners' Association, the numbers of mills at August 31, 1948, in the Dominion of India and Pakistan show little change as compared with those a year previously. The number of mills at August 31, 1948, is given at 422, compared with 421 in the previous year, though the paid-up capital of the mill companies was some Rs. 116,000,000 greater, at nearly Rs. 750,000,000. The number of spindles installed, at 10,433,000, was 80,000 more than a year previously, though the number working, at 9,580,000, was 4,000 less, while the number of looms installed was 600 less at 202,000, though the number working, at 185,000, was 600 more. At the end of last season, according to the report, there were 36 mills in course of erection in India and Pakistan. Compared with 1939 the number of mills has increased by 33, and the number of spindles installed by 374,000, but the number of looms has fallen by 400. Cotton consumption is given at 4,283,000 bales in 1947-48, against 3,972,000 bales in 1945-47 and 3,810,000 bales in 1938-39.

269. Pakistan: Cotton Laboratory. (*Pakistan Weekly News*, 21/5/49.) The Pakistan Central Cotton Committee has decided to set up a Technological Laboratory at Karachi and has made a provision of rupees one lakh for purchase of equipment and apparatus during the current year. The laboratory will carry out technological tests on varieties of cotton already grown in Pakistan and new varieties introduced from time to time. It will help the trade in assessing the spinning properties of the various cotton varieties and will advise the cotton breeders about the development of cotton varieties.

270. Textile Production. (*Ambassador*, 3, 1949, p. 134.) Pakistan is planning a large-scale production drive to develop its natural resources—cotton, hides, jute, etc.—to the utmost, and to make full use of its mineral wealth, petroleum and water power. Capital, machinery and technical knowledge are required, in addition to the raw materials of production, and the Ministry of Finance has invited foreign capital to participate in the industrial development of the country; no restrictions are likely to be imposed on the remittance of profits, apart from those which are necessary to control the exchange position. The approximate cotton crop, in a normal year, is about 1·2 million bales. There are 12 cotton mills, with a total capacity of 166,668 spindles and 4,315 looms, and by working double shift these are able to produce 5,000 bales of cloth and 750 bales of yarn a month; this is about 10 per cent. of the total amount of cloth required by Pakistan. During the next five years, a target of 2·5 million spindles is aimed at; for the present, in spite of no lack of private enterprise for the establishment of new textile mills, shortage of machinery and building material is hindering progress. A mill with a capacity of 31,000 spindles is now nearing completion at Rahimyarkham, in the State of Bahawalpur, and this should be in production early in 1949. Another, with a capacity of 25,000 spindles, at Karachi, will be producing by June, 1949, and the United States has received orders for the plant necessary for establishing two other mills, in Karachi and West Punjab. The United Kingdom has received orders for the plant required by two additional mills, both in West Punjab, and two mills in East Bengal have placed orders for an additional 17,000 spindles. By the end of 1949, the number of spindles in Pakistan will, it is estimated, have increased from 166,000 to 332,000. No serious difficulty is expected in obtaining textile machinery from overseas.

COTTON IN THE EMPIRE

271. AFRICA. INCREASED COTTON PRODUCTION IN BRITISH AFRICA. By N. Willatt. (*Crown Colonist*, February, 1949, p. 75.) The recommendations contained in the Interim Report of the Colonial Primary Products Committee to the effect that the output of cotton from existing areas should be increased, and that the development of new areas should be further examined, have a special significance for the British Colonies in Africa. While it is anticipated that the yield of seed cotton would be greatly increased as a result of the research work now being carried out, it is generally agreed that one essential pre-requisite to any effective increase in the output is an all-round improvement in the standard of cultivation. The establishment of the new Central Cotton Research Station which the Empire Cotton Growing Corporation is constructing at Namulonge, in Uganda, should give impetus to research activity throughout the continent, but experience has shown that the African cultivator tends to regard cotton as a cash crop of secondary importance to the food requirements of his household, and constant supervision and instruction is necessary to encourage him to make the consistent effort needed to raise the level of production. In addition to the expected increase in cotton production resulting from research work and improved cultivation, there is speculation as to whether the situation may not call for the opening of entirely new land to large-scale cultivation. It is thought that with the co-ordinated migration of Africans from over-populated areas and the widespread employment of insecticides, much new land might be made to produce cotton in a relatively short period. A further incentive to production would be the establishment of a stable price, but this is largely dependent upon improvements in the ginning and marketing of the crop. In Uganda, where supervision of grading and marketing is extremely difficult owing to the large number of gins in operation, it is suggested that the establishment of a scheme similar in organization to the Sudan Plantations Syndicate would greatly help to stabilize the quality of the crop. While it is not expected that large-scale mechanization will be introduced as a measure to obtain an immediate increase in cotton production, it seems likely that some increase will become apparent consequent upon the introduction of mechanized techniques for other crops in areas where cotton is grown, such as groundnuts.

272. BRITISH COTTON GROWING ASSOCIATION. The forty-fourth annual report of the Association to December 31, 1948, states that while it is disappointing to have to record a decrease in cotton production in 1948 (62,300 bales below that in the previous season, and between 331,000 and 335,000 bales below the peak production seasons of 1941 and 1938) it has at the same time to be recorded that the principal causes were climatic and other conditions, rather than diminished interest. In the Anglo-Egyptian Sudan the difference (100,000 bales) between the 1948 Sakel crop and the record crop of 1945 is entirely a difference of yield. In the first-mentioned season somewhat unfavourable climatic conditions caused a rather low yield, while favourable climatic conditions resulted in a bumper crop in 1945. A decline in production in Uganda of over 60,000 bales from the previous season, and of 200,000 and 240,000 bales from 1941 and 1938 respectively, was occasioned solely by unfavourable climatic conditions. In Nigeria a decrease of around 13,000 bales on the previous season's exports and of over 50,000 bales on the 1941 season, was due to unfavourable growing conditions, plus the intense demand with very high prices from the local manufacturing industries for such cotton as was available. In Uganda and Nigeria, however, plantings during 1948 (crops to be harvested in 1949) have increased substantially. To attain crops of the size of pre-war and early war years, given anything like reasonably favourable climatic conditions, is something that can be achieved in the comparatively near future. An improvement on those is also possible and should be realized as conditions imposed by war are gradually overcome. Amongst the factors required are improved transport services—road and rail—the strengthening of agricultural staffs, and the general adoption of proved better methods of cultivation, supplemented in some places by mechanization, with

a more general use of fertilizers and the use of insecticides for pest and disease control. All the cotton-producing countries are better placed than formerly to finance development, in addition to which large sums are available to many of them from the United Kingdom through Colonial Development and Welfare Funds. The translation of financial capital into capital goods for the needs of the cotton-producing countries is a slow process, for the requirements of these countries, particularly steel (locomotives, rolling stock), chemicals, etc., are the same as the requirements of the rest of the world. The Colonial Primary Products Committee in an Interim Report published early this year placed cotton production in Priority I, and stated: " The Committee has had no difficulty in establishing the need for expanding as rapidly as possible the production of Colonial cotton of a staple length of between $\frac{15}{16}$ of an inch and $1\frac{1}{16}$ inches." To these cottons can undoubtedly be added the rather longer staple cottons of Uganda and the Egyptian-type cottons grown in the Sudan.

273. East African Economic and Statistical Bulletin. (E. African Statistical Dept., Nairobi. No. 1, September, 1948. Ann. Sub. 30s.) The object of this quarterly Bulletin is to provide information on economic conditions in a readily accessible form. It is hoped that it will be of great assistance to all those requiring a common quantitative basis on which to plan economic development or discuss future trends. Much of the data contained in this Bulletin has been published previously either by Government Departments, or is of the type published annually in Blue Books or other reports, but the information has been studied and scrutinized and definitions are given for all the data included. In subsequent issues it is planned to include articles of economic interest on East African territories; the section devoted to Notes on Economic Development and Trends will be enlarged considerably and new subjects will be included after the Department has studied the existing statistics.

274. Report on the Water Resources of East and Central Africa. By F. Debenham. (From *Cr. Col.*, March, 1949, p. 145.) In his report the author states that the water supply in Central and East Africa is adequate but cannot be used with full efficiency without artificial aid. He urges that the drilling of bores and the sinking of wells should be supplemented by the conservation of rainfall both in the soil by means of contour furrows, and in surface reservoirs. It is suggested that certain floating plants might be used to prevent the loss of water by evaporation from the reservoirs, or a suitable solid wax might be melted and sprayed into the air over the water, to fall as tiny pellets of wax dust. Water conservation by the construction of surface weirs is particularly suitable for Northern Rhodesia and Nyasaland, but in parts of Bechuanaland, Kenya and Tanganyika, the porosity of the stream beds and the rate of evaporation preclude these methods. The aim here must be the provision of stock watering points, spread over as large an area as possible in order to distribute the grazing. The North-West Division of Bechuanaland is said to have an ample supply of water, and it could become a second Sudan, growing cotton or other products for export, provided it has reasonable access to the sea. In suggesting methods of conserving water, Professor Debenham emphasizes that the African should be taught how he can help himself by many small-scale simple schemes instead of relying on Government assistance.

275. Kenya: Cotton Crop. (Brit. Cott. Grwg. Assen., Anl. Rep., 1948.) There was a slight drop in cotton production in the season 1947/48, the total being just under 5,000 bales. From 1942/43 to 1946/47 it has remained fairly steady at around 5,000 to 6,000 bales a year. In the Coast Province production totalled 1,212 bales and in Nyanza Province it reached 3,655 bales.

276. Report on the Upper Tana River Irrigation Project. (Govt. Printer, Nairobi, 1949. Price 5s.) The Tana River, being the largest river in Kenya, has, ever since the earliest days, claimed the attention of all people interested in developing the natural resources of the country. It has been the subject of many reports and proposals, by both technical men and laymen, and the views expressed vary from extreme caution to excessive enthusiasm. While records are still far from

complete, there is now sufficient reliable information available for the true possibilities to be assessed, and it is found that, so far from being a "miniature Nile," the Tana River is really quite insignificant. It is unreliable and is suitable only for a very moderately sized irrigation scheme. This report deals with the possibilities of irrigation from the upper reach of the Tana River, which extends from Grand Falls to Bura.

277. Nigeria: Progress Report on Cotton Growing, 1947-48 Season. (*Prog. Rpts. from Exp. Stats.*, 1947-48.) *Northern Provinces.*—Samples were sent to the Shirley Institute from two mulched treatments and from the control with the object of discovering whether September or October mulching would have any beneficial effect on yield or quality. The differences between the treated samples and the control proved, however, to be small and of doubtful significance. Samples of all varieties in the Samaru trial were sent for analysis, and Strain 261 was outstanding by reason of its relatively low mean and standard fibre weights, and also by reason of its appearance, being level and free from nep. In the Daudawa trial Commercial Allen gave the lowest fibre weight. In both trials N'Kourala gave the strongest yarn. Samples of 26C from four sowing dates were sent for tests and it was shown that fibre from late-sown plots was not less mature. From a collection of strains sent by Mr. J. B. Hutchinson and grown in small plots at Daudawa, Koghuzi, Parbhani, Esfahan, M.U.8 and B.181 proved early vigorous types and were selected for further trial. M.U.8 was especially vigorous and a heavy cropper. Two fertilizer trials were also carried out at Daudawa. The first trial was to compare the results of superphosphate applications at different rates per acre and at different rates of dilution with soil. The treatments were: No manure; 25 lb. p.a. at dilutions 1 in 260 and 1 in 52; 100 lb. p.a. at dilutions of 1 in 65 and 1 in 13. The mean increase over the control of the treatments with 100 lb. superphosphate per acre was 1,370, which was equivalent to 193 lb. seed cotton per acre. This was valued at 41s. 6d. while the cost of superphosphate was 20s. 0d. Similarly, at the lower rate of application the increase was valued at 24s. 6d., while the cost of fertilizer was only 5s. The second trial was concerned with the placement of nitrogen and phosphate.

Western Province of Southern Nigeria.—At Ibadan the growing season was abnormally wet, the rainfall in the four months July-October totalling 42·9 inches as against a mean figure of 18·6 inches for the same months in the five previous years. The plants in both the selection and multiplication plots were very severely attacked by *Helopeltis* and the crop was almost a complete failure. In trials made by the entomologist there was some evidence of reduced damage in plots sprayed at monthly intervals with 5% wettable DDT, and further trials on this point are to be made.

The failure of cotton at Ibadan in recent years has completely upset the scheme for provision of Ishan A seed for farmers' use, which involves multiplying selected seed for three years at Moor Plantation and then for two years in the Meko district of Abeokuta Province. The visit of Messrs. J. B. Hutchinson and E. O. Pearson provided a good opportunity for reviewing the scheme. In accordance with their suggestions, an effort is to be made to avoid *Helopeltis* damage by growing the selected seed on Moor Plantation in cover of other crops and with protection of insecticides. Alternative sites for the early stages of multiplication are also being sought in more heavily forested areas where observations suggest that damage by this pest is less severe.

278. Nyasaland: Crop Prospects. (Dept. Agric. Rep., May, 1949.) The number of gardens in all areas shows a marked decrease from last year. In the Southern Province, in the Fort Johnston, Zomba and Blantyre Districts, cotton which was planted early and survived the drought has come on well and prospects are fairly good. On the Lower River a considerable acreage was planted during the month and germination is excellent. With sufficient rain during April for the plants to become established there may yet be an appreciable crop. In the Central Province the crop is negligible, only a few gardens having survived the drought. In the Northern Province prospects for the coming crop are poor, especially as it has been

necessary to take steps to restrict cotton planting to ensure that sufficient foodstuffs are grown. Altogether, the cotton acreage is expected to be well below normal, as the semi-flood land will not be in moist enough condition to carry a crop and the true flood land will be occupied for too long by late-planted rice. Arrangements have been made to complete the buying of the 1948-49 crop (estimated at 200 tons) by about mid-April.

279. COTTON CROP. (*Ann. Rpt. Dpt. Agr.*, 1947, Pt. I. Received 1949.) In the Lower River District of the Southern Province, which is the main cotton-growing area of the Protectorate, planting conditions for this crop were difficult, and planting was not completed until March. In spite of a slight decrease in the number of gardens in this district, the crop was rather more than 21 per cent. greater than in 1946, a result mainly due to the comparatively light boll-worm attack. In the small cotton-growing area of Blantyre District there was also a slight reduction in the number of growers, but the good rains in November enabled people to plant early and the crop was approximately 16 per cent. greater than in the previous year. In the Fort Johnston and Zomba Districts, the number of growers was only 50 per cent. of that of 1946 and the crop was only 28½ per cent. of the 1946 total. The main reason for the decrease in the number of growers was the poor crop and the low price of 1946 and the fact that cotton was competing with higher-priced tobacco grown in the same area. Over the whole of the Southern Province the cotton crop was 14½ per cent. greater than in the previous year, and with a guaranteed price of 3d. per lb. for seed cotton the monetary return to the growers was very satisfactory. After declining steadily for some years cotton production in the Central Province was increased in 1946 as a result of propaganda and a guaranteed minimum price of $1\frac{9}{16}$d. per lb. The monetary return, however, was insufficient to maintain interest, and in spite of timely advertisement of the fact that the price would be 3d. per lb. in 1947, the number of growers decreased in almost all districts and the total production was just under half that of 1946. Cotton grown in the main producing area of the Lower River District suffered less damage from red bollworm (*Diparopsis castanea*) and stainers (*Dysdercus spp.*) than in 1946, and this resulted in an earlier and cleaner crop. In the Central and Northern Provinces this crop was remarkably free from pests.

280. SOUTHERN RHODESIA: AGRICULTURAL RESEARCH. (*E. Afr. and Rhod.*, 26/5/49.) Sir Frank Engledow, in his report to the Southern Rhodesian Minister for Agriculture, has suggested the establishment of a central laboratory in Salisbury, field and husbandry experimental stations in the chief agricultural regions of the Colony, and sub-stations in special localities for agricultural research. The central laboratory would provide for investigation of a strictly scientific nature, while the field or husbandry stations would experiment with new crops, implements, and methods of live-stock management.

281. COTTON INDUSTRY. (*12th Ann. Rpt. Cott. Res. and Indus. Bd.*, 1947-48. Received 1949.) Local production of absorbent cotton-wool during the period under review totalled approximately 125,000 lb. Four new carding machines are in the course of erection. Yarn production for the same period amounted to 732,514 lb. Plans have been submitted for the erection of a second spinning mill of approximately 17,500 spindles. It is intended that this mill shall spin 14's to 24's counts and that the mill now in operation shall spin only medium fine counts from 28's to 40's. The combination of the two mills will constitute an economic unit capable of spinning the range of counts demanded in Southern Rhodesia, suited to the types of cotton grown in the country and procurable in adjacent territories. It is estimated that the time required to build, equip, and install the machinery in the new mill will be 2½ to 3 years.

Cotton Research Station, Gatooma, Progress Report 1946-47.—Attacks by Jassid and American bollworm were light, and Sudan bollworm was the only pest of importance on the station. The attack by this pest lasted throughout the life of the plants. Where attack and damage was least severe, yields ranged from 450 to 600 lb. of seed cotton to the acre, despite drought conditions. Yield returns from

the Main Variety Trial confirm those of the previous season—namely, that derivatives of the 7Cs. (Gatooma U.4 × Cambodia) × U.4 are as good as, or possibly better than 9L34, the strain at present in commercial cultivation and a descendant of the original U.4 material. A number of Barberton strains, also derived from U.4 × Cambodia crosses, were grown in trials for the first time this season at Gatooma and yielded well.

282. South Africa: Cotton Industry. (*Cott. and Genl. Econ. Rev.*, 25/2/49.) Cotton consumption requirements in the Union of South Africa have expanded rapidly in the past few years and are expected to continue to expand for some time to come as new mills are built. The Barberton Cotton Co-operative Ltd. estimates cotton consumption requirements in 1949 will reach 50,000 bales; in 1950, 75,000 bales; and by 1951, 100,000 bales. These estimates represent a sharp increase over the 14,000 bales reported consumed during the 1947-48 season and are based on prospective consumption by three relatively large new mills that were expected to be in operation after the middle of 1948. The spinning and weaving of cotton in the Union was begun during World War II with only one mill in full operation prior to 1948. If these forecasts are realized, 90 per cent. or more of these quantities must be obtained by importation.

Preliminary estimates indicate a cotton crop in the 1948-49 season of 5,000 bales. This compares with 2,500 bales produced in 1947-48 and 890 bales in 1946-47. Some sources connected with the industry do not expect cotton production to rise above 10,000 bales as long as prices remain at or below the present level, although the 1925-26 crop was over 16,000 bales. In any case it appears that South Africa will depend on imports of raw cotton to fill part of their consumption requirements. In the first half of 1947 the Union of South Africa imported 11,000 bales of cotton as compared with 18,000 bales in the calendar year 1946. Most of the cotton in this period was received from other African areas, India and Brazil, with very little from the United States. Recently, however, the Union has been increasing imports of American cotton. In the 1947-48 season the United States exported 3,300 bales to the Union, and about 600 bales were exported from August through November of 1948.

283. Cotton Crop. (*Overseas Rev.*, Barclays Bank, February, 1949.) Favoured by good climatic conditions an excellent crop was reaped in the 1947-48 season, amounting to 2,453 running bales as compared with 919 bales in the previous season. This is the largest crop since 1936-37. The principal production areas are in Zululand, the Eastern Transvaal and Swaziland. Improved prices and the expansion of secondary industry locally had placed South African cotton production on a firm basis. It is believed that the acreage under cotton in the 1948-49 season will approximately treble that of last season. Good rains gave the crop a promising start, but this has been partly offset by the drought. The likely output is difficult to estimate.

284. Sudan: Cotton Crop, 1948. (*Crown Colonist,* June, 1949, p. 378.) The value of exports from the Sudan in 1948 was £E25,500,000, which was 59 per cent. higher than in 1947. This was almost wholly attributable to the high prices obtained for raw cotton, which fetched £E16,000,000 against £E9,500,000 for about the same tonnage in 1947.

285. Achievements of the Sudan Plantations Syndicate. By M. Langley. (*Crown Col.*, May, 1949, p. 279.) In this article the author reviews the history of the Sudan Plantations Syndicate during the past 25 years of co-operation between the Sudan Government, the Syndicate and the tenant-cultivator. Under this three-fold partnership a record export of 357,848 bales of cotton was shipped from Port Sudan in 1945. Much credit for the increase in yield, which now stands at about 1,248 lb. per acre, is given to the Syndicate's block inspectors, whose responsibilities are arduous and varied. Under the Nile Waters Agreement of 1929, the quantity of water diverted from the Blue Nile to the Gezira may not exceed 922 million tons per annum. Present consumption leaves a margin of 150 million tons on this figure and the Sudan Government intends to use this surplus for the further

development in the Gezira crop. A plan to enlarge the main canal to take an increased flow is now being realized. This at present is the only large-scale constructive work in progress in the area. Efforts are today directed mainly towards the elimination of pests and diseases, the standardization of the quality of the cotton, the maintenance of a high yield, and the welfare of the 20,000 tenant-cultivators and their representation through village councils. Next year the technical and supervisory duties of the Syndicate will be assumed by the Government. These duties, conscientiously carried out, have contributed greatly to the production of a cotton crop worth up to £7 millions a year to the Sudan.

286. Tanganyika: Cotton Crop. (*Overseas Rev.*, Barclays Bank (D, C and O), April, 1949.) Ginning of the 1948 crop in the Lake Province of Tanganyika has been completed with a final outturn of 45,649 bales, compared with 32,450 bales in 1947. The unofficial estimate for 1949 is 50,000 bales, compared with last year's estimate at this stage of only 33,000 bales.

287. A Vegetation-Types Map of Tanganyika. By G. Gilman. (*Geog. Rev.*, January, 1949. From *Nature*, 5/3/49, p. 356.) This study of the natural vegetation of Tanganyika Territory should be used as a basis for planning and development. The classification is strictly physiognomic and provides an essential basis for further ecological and geographical investigations. The main types of vegetation shown on the coloured map on a scale of 1 : 2,000,000 include forest, woodland, bushland and thicket, grassland, permanent swamp, desert and semi-desert, and vegetation actively induced by man in native and non-native cultivations. The term " actively induced vegetation " includes the mixed and constantly changing pattern of cultivated crops, pastures and interspersed remnants of the original vegetation and of scattered small areas of secondary growth. Complexes of vegetation occurring in close conjunction are shown on the map symbolically, using the colour of the dominating type for the ground colour with intrazonals or complexes shown by circles or dots in the colour of their type. The map brings out at a glance the small remnants of evergreen forest left on the main watersheds, and the author stresses the urgency of the threat to the country's water resources. The map also rectifies a commonly held exaggerated view of the size of alien plantations and farming settlements, which appear as tiny specks compared with the great extent of native-cultivated land.

288. Uganda Cotton. (*E. Afr. Econ. and Stat. Bull.*, 2, 1948.) This article gives a brief history of the Uganda crop from the time of the first recorded exports of cotton in 1904-5. Uganda's output is more than 80 per cent. of East Africa's total cotton crop in a normal year, and is the second highest in the British Commonwealth and the tenth in the world. The actual acreage under cultivation is only exceeded by five other countries, but production is insignificant by world standards, being only 1 per cent. of the total world output. It is also less than 3 per cent. of the production of the United States and 10 per cent. of that of India.

289. Crop Prospects. (*Cott. and Genl. Econ. Rev.*, 8/4/49.) The weather has not changed for the rainy season and fears are entertained in rural areas about the successful planting of food crops. Marketing of seed-cotton has continued to progress satisfactorily, and by end-March will be completed, reaching 350,000 to 355,000 bales. Final figures of marketing A and B qualities will not be available until mid-April. The Government's policy is to increase Uganda raw cotton production to 500,000 bales annually. Plantings will be made earlier throughout the Protectorate. Arrangements have been made to improve the grade of BP.52 strain by the distribution of pure seed throughout Buganda, where in previous seasons the seed became mixed. The next crop of BP.52 variety is therefore expected to show a marked improvement in quality. An official communique recently announced that the prices to be paid to producers of cotton, groundnuts and tobacco planted in 1949 will remain unaltered at the price levels fixed for the 1948 crop season. This means that for seed-cotton the grower will again receive Shs.30 per 100 lb. It has also been agreed that Native Administrations will continue to receive Sh.1 for every 100 lb. of seed cotton purchased in their areas during the 1949-50 season.

290. UGANDA COTTON COMMISSION. (*E. Afr. and Rhod.*, 19/5/49, p. 1178.) In a statement issued by the Uganda Government after consideration of the report of the recent Cotton Commission, it is claimed that there has already been an improvement in the general position with regard to cotton buying, and that there is virtually no evidence of malpractices during the 1948-49 buying season. A lint marketing board will be established to assume the functions of the Cotton Exporters' Group before the start of the 1949-50 season. It will be composed of the Financial Secretary, the Director of Agriculture, a representative of the ginning trade, an exporters' representative, and three Africans.

Among the recommendations of the Commission which are accepted are: an earlier opening of the buying season; encouragement to co-operative societies; the abolition of buying licences as the existing middlemen disappear; African participation in the ginning industry; the spreading of buying over a large number of centres, and the establishment of buying stores near Gombolola or Maruka headquarters; revival of the inspection of stores; the erection of stores by the Central Government and local authorities; instruction of growers in the reading of figures; the employment of Africans to do the weighing, and the provision of scale supervisors; the use of a standard basket for weighing purposes; the layout of buying places; the ticket system in buying; and the clear definition of the buyer's responsibilities to the seller.

291. AUSTRALIA: COTTON CROP. (*Cotton Marketing Bd.*, 7/2/49. From *Cott. and Genl. Econ. Rev.*, 18/2/49.) The cotton-growing industry in Queensland is passing through a most difficult phase of reconstruction. In pre-war years the industry was producing from 12,000 to 18,000 bales of raw cotton annually, but as a result of the Commonwealth Government's wartime policy to reduce cotton production and increase food production, the cotton-growing industry declined to an entirely uneconomic level. From 1941 production fell rapidly, and in 1945 only 1,300 bales of raw cotton were produced. During the last three years the production has remained around 1,500 bales of raw cotton per year. While the promise was given that the basic structure of the industry would be maintained, this was not done, and the return to growers was maintained at the 1941 level until September 30, 1948, when price controls were withdrawn in the Commonwealth. The future of the cotton-growing industry in Australia largely depends upon its production with the aid of irrigation and the adoption of complete mechanization of cotton production. In regard to the first essential, the Queensland Government has embarked on a very comprehensive scheme of water conservation and irrigation, but the implementation of this will naturally take many years to carry out. The second essential, the complete mechanization of cotton production, is definitely on the way in the United States, and this makes possible the introduction of this method to Queensland. On these two essentials, water and mechanization, the cotton-growing industry of Queensland can look forward confidently to building up a sound, efficient industry, to supply the requirements of Australian cotton spinning mills.

292. COTTON TEXTILES. (*Cott. and Genl. Econ. Rev.*, 14/4/49.) The industry continues to expand in spite of labour shortages and difficulty in securing equipment. It is estimated that present equipment is not operating more than 60 per cent. of capacity and on a one-shift basis due to the labour shortage. Plans for expanding textile capacity are proceeding, and it is anticipated that 50,000 to 100,000 spindles will be installed in 1948 and 1949, adding up to 50 per cent. of the present capacity of 200,000 spindles. Also 300 to 500 additional looms are expected to be set up, adding to the present equipment of about 3,000 looms. This will be marked increase from the 91,000 spindles and 1,250 looms in operation in 1938-39.

Cotton consumption in the 1947-48 season was reported at 61,000 bales (500 lb. gross) or about double the consumption in the 1938-39 season. However, local cotton textile production still supplies less than 20 per cent. of domestic needs, and the Australian cotton crop can supply only 2 to 3 per cent. of the raw cotton requirements of the Australian mills. India and the United States have traditionally been the chief source of raw cotton imports, but due to the necessity of curtailing dollar expenditure, imports from the United States have been curtailed, and as

much as has been possible has been obtained from India, Egypt, Brazil and other countries where payments can be made in sterling.

During the war years and to June 30, 1948, the Commonwealth Government has procured all cotton used by the Australian mills. Both the imported and domestic cotton were then made available to spinners at prices which were stabilized well below world prices, and the difference was paid by the Commonwealth Government. This practice, which amounted to a subsidy to the textile industry, ended on June 30, 1948, and spinners now are obtaining supplies through private trade channels. Under the Commonwealth Raw Cotton Bounty Act, the Australian Government bought the domestic crop at fixed prices. These guaranteed prices had not been increased since 1941 and, as production costs increased, lower returns were received by the growers and cotton production declined. As a result of the lifting of government control over raw cotton and cotton prices, the 1948-49 crop will be sold at the import parity prices for raw cotton. If present world prices are maintained, this will mean an increased return to the growers for the current crop. In 1947-48 Australia's cotton production was estimated at 1,550 bales as compared with a pre-war average of 11,000 bales. Irregular rainfall and storms caused a large abandonment of acreage and low yields. It is estimated that the acreage planted in the current season is even less than last year's, and this year's crop (harvested April to June) may be no larger than last year's.

293. WEST INDIES. West India Committee. Report of the Executive Committee for 1948-49. (*W. Ind. Comm. Circ.*, May, 1949, p. 109.) The area planted to Sea Island cotton in the 1947-48 crop season, excluding the acreage in St. Lucia, rose from 7,265 acres (in 1946-47) to 9,386 acres. Plantings in St. Kitts were better than had seemed likely when the annual report for last year was compiled, but attained only 333 acres, against 986 acres in 1946-47. The other islands all contributed to the increased acreage. Total British West Indian production was 1,538,902 lb., or 3,847 bales of 400 lb. each. The f.o.b. price per lb. received for clean lint ranged from 2s. 9d. (in Antigua) to 3s. 6d. (in Barbados, St. Vincent and St. Lucia). Marie Galante cotton was grown only in Carriacou, 115 bales of lint being produced from an area of approximately 1,200 acres. The estimated B.W.I. cotton crop for 1948-49 is 2,277,500 lb. lint, or 5,695 bales, and the f.o.b. prices agreed up to September, 1948, were 3s. 6d. per lb. (Nevis and Antigua) and 4s. 2d. (St. Vincent and Barbados).

While an upward trend in prices benefited producers during the past year, there has been increased competition from finer growths of Egyptian cotton, and the demand from spinners and weavers has tended to be for superfine and the highest grades of M.S.I. It is noted that action taken in the West Indies as a result of the proposals of Mr. P. W. Briggs, who was delegated by the Colonial Office and the British Cotton Growing Association to report on conditions in ginneries in the islands, has resulted in a marked improvement in the standard of ginning and preparation of Sea Island cotton.

294. Montserrat: Cotton Crop, 1949. (*Crown Colonist*, June, 1949, p. 388.) Recent reports have stated that the outlook in Montserrat, for the 1949 cotton crop, was encouraging and that it was expected that some 4,000 acres would be planted. There has been an increase in the price of clean lint, the Cotton Purchasing Commission offering, according to grade, from 3s. 7d. per lb. to 3d. 10d. per lb. The experts' report in the first shipment made of the 1948 crop revealed that the clean lint below Grade 2 showed a falling-off in lustre and irregularity in the length of staple. Deterioration in the quality of the seed planted is a suggested cause.

COTTON IN THE U.S.A.

295. America: Cotton Crop, 1948-49. (*Cotton*, M/c., 14/5/49 and 2/4/49.) Revised figures of the 1948 American crop put production at 14,868,000 bales against 14,937,000 bales estimated in December, and 11,851,000 bales for the 1947 crop. The yield per acre, at 313·1 lb., established a new high record. It compares with 267·2 lb. a year ago and the previous record of 298·9 lb. The area in cultivation

on July 1 last year was 23,110,000 acres, of which 22,768,000 were harvested, compared with 21,500,000 acres and 21,269,000 acres, respectively, in 1947. The Department of Agriculture state that the average grade of the crop was lower than that of the 1947 crop, but the average length of staple was considerably greater.

296. Cotton Crop Acreage, 1949-50. (*Cotton*, M/c., 19/3/49.) The Department of Agriculture's cotton acreage goal for 1949 is 21,894,000 acres, or the same as its final revised acreage goal of a year previous. Prior to 1948 actual plantings by United States cotton growers had always been less than the goals set by the Government, but last year growers planted a total of 23,372,000, or 1,478,000 more than the Government's 1948 goal of 21,894,000. Recent estimates of the prospective acreage average around 25,500,000 acres. The greatest increase is expected in Texas, Oklahoma, Arizona and California.

297. Cotton Crop Acreage, 1949-50. (*Cotton*, M/c., 30/4/49.) Latest advices received from the south state that the south-east is planting about 12 per cent. more than last year, whilst in Texas acreage increases range from 10 to 35 per cent. In Oklahoma an increase of approximately 15 per cent. is expected.

298. America: Production of Long Staple Cotton. (*Cotton*, M/c., 30/4/49.) Advices from Arizona state that the resumption of acreage controls on ordinary American cotton is expected to revive interest in production of extra staple varieties of the American-Egyptian type. Anticipating this situation, the United States Field Station at Sacaton has developed a new long staple variety known as Pima 32 and is recommending its acceptance by long staple cotton growers. Some 300 acres will be planted with the new variety this year, in Arizona and South-western Texas, under conditions that will permit the increase to be used for high quality planting seed in 1950. Laboratory tests show that the fibre of Pima 32 is 12 per cent. stronger than S×P, the present commercial long staple variety, and preliminary spinning tests indicate a substantial improvement in yarn skein and strength. The results of several commercial mill tests with the new cotton are not available. Field tests carried on over a period of four years at Sacaton show that Pima 32 has a high yielding capacity for a long staple cotton. It averaged 456 lb. of lint per acre, an increase of 50 per cent. over the 301-lb. average of S×P.

299. American Cotton Industry: Research Programme. By L. Smith. (*Amer. Dyes. Rept.*, 37, 1948, p. 866. From *Summ. Curr. Lit.*, xxix, 5, 1949, p. 90.) The research programme for the cotton textile industry as planned under the United States Agricultural Research and Marketing Act of 1946 is discussed. The programme includes both fundamental and applied research, and approved research projects are listed and outlined.

300. Labour Management in the American Cotton Industry. By L. H. C. Tippett. (Brit. Cott. Ind. Res. Asscn., 1949.) This report is based primarily on visits to seven mills in the United States, and on discussions with a number of people in the management, trade union and academic worlds. The first section gives a few general impressions which add a little to the picture given by other accounts, notably the Platt Report. The second section on labour management reports that although work study has been formally adopted by the employers and unions as a basis for work-load assessment, its use is a comparatively recent development in the American textile industry, it has not yet much affected the job assignments of the operatives in most mills, and the practices and the extent of their application vary considerably from one mill to another. The third section describes the attitudes and activities of the trade unions, and the last section reports on American methods for controlling count, cloth defects and other aspects of quality.

301. Cotton Cloth. (United States Tariff Commsn., Wash., 1947, pp. 142.) This report gives the results of investigations carried out by the Tariff Commission with regard to the pre-war status of the cotton mill industry and the changes and developments that have occurred during the war, and the probable post-war status of the industry in relation to foreign trade and international competition. Many excellent tables accompany the text, which includes much interesting information on world cotton production and trade generally.

302. Report of the Proceedings of the Second Annual Beltwide Cotton Mechanization Conference, Lubbock, Texas. See Abstract No. 345.

303. California: Cotton Improvement. By G. J. Harrison (*Cott. Trade J.*, 28, 1948-49, p. 154. From *Text. Tech. Dig.*, 6, 4, 1949, p. 257.) The development of California cottons is reviewed briefly, and data are given on the characteristics of a new strain, Acala 4-42. A programme is now under way to transfer the fibre properties of this strain to other cottons because its small bolls and low lint percentage preclude its production under present economic conditions.

304. Georgia. (*59th Ann. Rpt. Ga. Ext. Sta.*, 1947-48. Received 1949.) A study of cotton marketing from a regional viewpoint was undertaken, with 12 of the cotton-producing states participating. The purpose of this study was to examine the regional marketing of one-variety community cotton, including cotton seed and other products, in relation to physical characteristics and capabilities, trade channels, mill requirements, marketing methods and costs. The first phase of the regional project was to determine the methods, practices, and channels now being used in moving cotton to mills and processors in order to compare marketing methods and channels of one-variety cotton communities with non-one-variety cotton communities and to study reasons for, and attitudes of, growers, ginners, and cotton buyers toward some of the practices now being used in marketing cotton. *Empire Cotton.*—Increased use of Empire Cotton by farmers in Georgia and other states has necessitated further expansion of the breeding programme at the Georgia Experiment Station and the seed multiplication programme conducted by organized groups of farmers in one-variety Empire communities under the supervision of the Station. Parent seed of Empire, produced by the Experiment Station, is distributed to approximately 500 growers, and is grown under the provisions of signed agreements to plant no other variety of cotton or to plant no Empire cotton less than 200 yards from any other variety grown in other farms. All fields are inspected by the Georgia Crop Improvement Association, and seed produced in fields which meet all requirements for isolation is certified as registered breeder or foundation seed of Empire. Under normal seasonal conditions, approximately 2,500 tons of foundation seed should be produced annually. The existence of resistance to cotton wilt in some selfed lines of Empire was first observed in 1944 and has been confirmed by tests conducted under severe wilt conditions in subsequent years. The results of cotton variety tests are given and experiments on cottonseed treatment and the application of fertilizers are also described.

COTTON IN EGYPT

305. Egypt: Cotton Crop. (*Overseas Review*, Barclays Bank Ltd., March, 1949.) The past month has been conspicuous for wide fluctuations in the long staple market. During the first few days of the month prices were sustained and March futures went to a premium of nearly $6 over May. However, the prices fixed for deliveries against the maturing March contract favoured would-be deliverers and, consequently, some 74,000 cantars valued at about £E1,250,000 were eventually tendered. Medium staple prices also declined to some extent in sympathy with long staple, but the lower levels have attracted heavy and sustained trade enquiry from abroad and there is now a keen enquiry on the spot market which is keeping prices relatively steady; high grades of Ashmouni, Zagora and Giza 30 have all been actively sought and the lower grades have also been selling freely to the local spinning trade. On the other hand, it is noticeable that the heavy decline in long staple prices has not attracted trade demand and it appears that spinners abroad will do their best to await next season's crop which promises to be a large one. The Egyptian Government have continued to sell by auction some lots of long staple against payment in hard currency.

Planting of the new crop is nearly complete throughout Egypt. A number of cultivators have been assuring themselves of a good revenue from their land by selling a part of their crop forward for delivery in October/November, 1949. It is

believed that the area of land planted in long-stapled Karnak has increased substantially; Giza 30 and Menoufi have also been popular, but the acreage under medium staple Zagora is reduced to negligible proportions.

306. Egyptian Cotton Crop: Statistical Position, 1948. By R. Dabbous. (*Egyptian Cott. Gaz.*, **6**, 1949, p. 89.) This article is mainly composed of tables giving comparative figures for the supply, export and consumption of the leading varieties of Egyptian cotton.

307. Egypt: Cotton Crop, 1949-50. (*Cotton*, M/c., 7/5/49.) In certain regions of Upper Egypt there have been complaints that colder and windier weather than normal is delaying slightly the growth of the plants, but on the whole the crop is making good progress and resowing is on a very small scale. In Lower Egypt the very bad weather of recent weeks has at last departed, and during the past few days very favourable conditions have reigned. This change arrived just in time, for the situation was becoming very serious. However, the young plants are now beginning to pick up well, and it is hoped that this bad and delayed start will gradually be made up during the remainder of the growing period.

308. Cotton in Egypt. By V. G. Panse. (*Ind. Cott. Grwg. Rev.*, iii, **1**, 1949, p. 1.) Observations on Egyptian cotton made during the visit of the author to the country in April, 1948, as a member of the Indian Delegation to the seventh meeting of the International Cotton Advisory Committee, together with information drawn from statistical and other data published by the Egyptian Government, are summarized in this report. The quality of Egyptian varieties, methods of seed control and of prevention of mixing of varieties and the improvement brought about in yield through the establishment of the Cotton Research Board are described. Recent developments in the conduct of spinning tests are referred to. A brief account of the Cotton Museum is given. In the concluding remarks the need for prevention of mixing in India through legislative measures and the importance of centralizing all cotton research under the Indian Central Cotton Committee are emphasized. A policy of maximum self-sufficiency is necessary in respect of India's cotton requirements.

309. Egyptian Cottons: Karnak and Menoufi, Cropping and Spinning. By C. H. Brown. (*Egyptian Cott. Gaz.*, **6**, 1949, p. 29.) In this article the author examines the relative merits of the Menoufi and Karnak varieties of cotton in order to establish his belief that Menoufi is superior to Karnak in yield, lint and spinning quality.

310. Egypt: Spinning Test Report on the Cotton Crop of 1948. (Min. of Agric., Spinning Test Mill, Orman, Giza. April, 1949.) Samples of the following varieties: Amoun, Karnak, Menoufi, Giza 23, Giza 30, Giza 7, Uppers Ashmouni and Zagora, were drawn from commercial deliveries as supplied by the courtesy of about 35 exporters. Spinning tests showed that the quality of the year's crop was about the same as for the previous year except for Giza 23, which was in previous years equal to Giza 30 in yarn strength, but in this year's tests exceeded Giza 30 by 110 lea product units in grade FG and 180 units in grade Good. The report states that the acreage under Giza 7 is gradually diminishing because of its marked deterioration, and growers are cultivating in its place mainly Menoufi and Giza 30.

311. An Outline of the Hybridization Technique employed at Giza. By M. A. Gaffar. (*Egyptian Cott. Gaz.*, **6**, 1949, p. 39.) The technique of artificial hybridization has been carried out at Giza since 1926, during which time many modifications and improvements have added to its effectiveness. Recently, however, the author started using the back cross technique with the intention of increasing the yield of certain high quality varieties which are very desirable from the quality point of view, but have not been launched on the market because of their low yield. Consideration is particularly given to increasing the ginning outturn or the boll weight of such super-quality low-yielding cottons as a means of increasing their yield. A third crossing technique has been recently employed at Giza with the object of producing a population with as many different characteristic combinations as possible, as a basis for selection. A simplified explanation of the technique employed for all these methods of crossing is given.

312. COTTON SEED: PEDIGREE CONTROL SYSTEM. By C. H. Brown. (*Egyptian Cott. Gaz.*, 6, 1949, p. 35.) The Egyptian Ministry of Agriculture is considering replacing the present system of seed control by one based on pedigree. The pedigree system (or dated seed system) is an attempt to select or reject lots of sowing seed on the basis of their known history rather than by the examination of the samples of seed or lint. The basic idea behind the suggestion of generalizing the dated system is that of trying to keep in circulation for sowing the minimum number of possible generations. It is assumed that every extra year seed is in circulation will add to the risk of its accidental contamination, and also give extra scope to any tendency to genetic degeneration which may exist in the seed. The possible commercial objections to the procedure are discussed.

313. BOLLWORMS: EFFECT ON QUALITY AND GRADE OF EGYPTIAN COTTON. By I. Bishara. See Abstract No. 347.

COTTON IN OTHER FOREIGN COUNTRIES

314. ARGENTINA: COTTON CROP. (*Cott. and Genl. Econ. Rev.*, 14/4/49.) According to the latest information received to end March, the estimated yield from the current crop is 400,800 metric tons of seed cotton, giving 110,000 to 120,000 tons of lint. This season, there will be little cotton grading Type A and a very reduced proportion of Type B, while Type C will probably comprise 50 per cent. of the total production.

315. LA INDUSTRIALIZACION DE FIBRA DE ALGODON EN LA REPUBLICA ARGENTINA, 1947. (Sec. Indus. Com., Dir. Algodon, Buenos Aires, August, 1948.) (In Spanish.) This mimeographed report (pp. 17) gives some general information about the cotton industry in the Argentine, with special reference to the industrial position in 1947. It also contains statistical tables concerning the number of mills and spindles operating in the country, the distribution and consumption of cotton, and yarn production.

316. BELGIAN CONGO: CROP PROSPECTS. (*Cotton*, I.C.A.C., February, 1949.) Dry weather hampered the planting of 1948-49 crop in the Northern Area of the Belgian Congo and necessitated considerable replanting. A shift in planting seed is reported this year from the Triumph variety to Stoneville. In the Southern Area the crop which was harvested in the period June to December, 1948, was 10 per cent. larger than in the preceding year. Planting of better seed is said to have improved the quality of this crop. The total 1948-49 crop in the Congo is tentatively placed at only a little larger than the 181,000 bales produced in the preceding season.

317. BRAZIL: COTTON CROP. (*Cott. and Genl. Econ. Rev.*, 14/4/49.) Local heavy rains in March may have caused some damage to the quality of the crop. The entries at the gins are rather slow, and it is assumed that the final yield will be in the neighbourhood of 220,000 to 230,000 tons. The market is at present very quiet, only local factories are keen buyers of the first lots appearing on the market, and prices have been pushed upwards by this interest, completely paralyzing export business. A great deal of the crop is already disposed of to countries with compensated currencies at the prices fixed by the Sao Paulo market. It is estimated that Sao Paulo will export about 150,000 tons this season, and that at least 100,000 tons will go forward to England, France, Australia and India.

318. COTTON PRODUCTION. (*Cotton*, M/c., 26/3/49.) Cotton is now being grown more extensively in the State of Rio de Janeiro, where a crop of approximately 14,000 metric tons is expected during the current season compared with 7,000 tons in 1947-48. The main cotton-growing areas—some of which are highly fertile—are in the northern part of the State, the principal centres being Itaperuna, Sao Fidelis, Cambuci, Natividade and Porciuncula. Successful efforts are also being made to revive cotton production in the State of Maranhao.

319. COTTON PRODUCTION. (*Cotton*, M/c., 9/4/49.) The Federal Minister of Agriculture is reported to have asked the Minister of Finance for a credit of Cr$36,000,000 for the National Campaign for the Recuperation of Cotton. All the cotton-producting States from Maranhao to Sao Paulo would benefit, and the alloca-

tions would be Cr$12,000,000 for mechanization, irrigation and drainage; Cr$12,000,000 for the cultivation of selected seeds; Cr$5,000,000 for plant protection (insecticides, etc.); Cr$5,000,000 for improvement of ginning plants and fiscalization; and Cr$2,000,000 for assistance to various subsidiary departments and societies working to the same end, and in the training of specialists.

320. Colombia: Cotton Industry. (*Cotton,* I.C.A.C., February, 1949.) In order to meet more nearly cotton requirements of domestic textile mills in Colombia considerable officially sponsored investment has been made with the object of increasing cotton production. Loans have been available to growers. Machinery has been purchased and technical advice provided. Cultivation of cotton is being developed in new regions where both soil and climate are especially suited to this purpose. Further support to the expansion of cotton production is being given by a private organization sponsored by the Colombia textile industry. Production in 1948-49 is tentatively estimated at 29,000 bales, the same as in the preceding season, but substantial increases are expected for 1949-50 and 1950-51. Consumption in recent years has approximated 100,000 bales. It appears to be fairly well stabilized at this level. Imports in 1947-48 totalled about 60,000 bales, most of which was Peruvian and Brazilian cotton.

321. Ecuador: Cotton Industry. (*Cotton,* I.C.A.C., February, 1949.) A recent report from Ecuador indicates a surplus of cotton textiles and the closing of at least one plant. Credits were, however, arranged by the Government with the Central Bank to permit resumption of operation. Cotton consumption in Ecuador totalled about 16,000 bales in 1947-48, of which 9,000 were produced locally and 7,000 imported. This is more than double the prewar level of consumption. With a reduced crop in prospect for 1948-49, import requirements will be larger. In the first three months of this season, about 7,000 bales were exported to Ecuador from the United States, Brazil and Peru.

322. French Indo-China: Cotton Cultivation. By A. Angladette. (*Cot. et Fib. Trop.,* 3, 3/4, 1948, p. 73.) During the second world war importations of cotton into French Indo-China were progressively reduced, and growers made substantial efforts to increase the cotton crop by extension of the cotton-growing areas and increased yields. In addition a large experimental programme was undertaken by the Technical Service of Agriculture, and this article reports these trials and prior studies about ecological conditions, varieties, cultivation, diseases and cotton pests in Indo-China.

323. Greece: Cotton Crop. (*Cott. and Genl. Econ. Rev.,* 6/5/49.) Cotton consumption in Greece is being maintained at about the same level as that of the past two years—namely, 85,000 bales annually. The domestic crop supplies about 60 per cent. of Greece's raw cotton requirements and about 40 per cent. is imported. Brazil and Egypt have been supplying most of the imports in the past, but imports of United States cotton financed by the ECA have been increasing. In the five months August-December, 1948, Greece imported 4,904 bales from Brazil, 3,716 bales from Egypt, and 894 bales from the United States. Imports from India and Pakistan, formerly important sources of supplies, have dwindled and in the same period amounted to only 370 bales. Greece is attempting to increase cotton production by maintaining prices at favourable levels and restricting imports. The 53,000-bale crop in 1948, however, is far below the 1935-39 average of 76,000 bales annually. Imports have been restricted as a matter of Government policy in order to save foreign exchange and to insure full utilization of the domestic crop and payment of a fair price to farmers.

The long-range outlook for increased cotton cultivation in Greece is very favourable and may reach the Government goal of 375,000 acres by 1953. This is over three times the 1948 area and above the prewar peak of 205,000 acres planted in 1937. The Government is giving much attention to increasing yields by bringing a larger percentage of cotton acreage under irrigation, by distributing and otherwise encouraging the use of improved and more productive varieties of seeds, by controlling insect pests, and by modernizing ginning facilities. Present plans for

construction of the principal dams and canals needed for irrigation of cotton and other crops are based on expected financing by the Greek Government with ECA aid. The farmers are being encouraged to organize themselves or make use of existing co-operatives for such purposes as undertaking construction projects and financing necessary expenditures. In several areas these programmes have already been put into action and irrigation projects have been started. All these factors and the fact that cotton provides the farmer with a relatively satisfactory income combine to make an encouraging long-range outlook for cotton cultivation in Greece.

324. GREECE: COTTON VARIETIES FOR, ACCORDING TO RESULTS OBTAINED BY THE COTTON RESEARCH INSTITUTE FROM 1932-1949. (*Cott. Res. Inst., Sindos. Sci. Bull. No.* 2, 1949.) The work of the Cotton Institute indicates that foreign varieties from the United States, Egypt, etc., with or without previous selection, are not suited to Greek conditions. The same, of course, applies to the Upland variety Acala, which for a number of years was grown rather extensively in this country. There is only one exception regarding a number of selections from the American variety Carolina Foster. They may be of considerable importance when a demand for good quality cotton is developed. The most promising strains are selections from local seed. At present 2Γ is used more widely than any other, because it combines several good characteristics. Under somewhat adverse conditions 17X and 2X give higher yields, and if the amount of moisture in the soil is very high, variety 6×17 is the best. If quality does not appreciably affect the price of cotton, variety 14×6 may be used with success. It gives up to 46 per cent. of lint which is rather short. If, on the other hand, there is a demand for good quality cotton with an adequate premium in price, varieties 9×8 and 9×6 are indicated, besides the selections from Carolina Foster or 53Δ.

325. IRAQ: COTTON PRODUCTION. (*Cotton*, I.C.A.C., February, 1949.) Available information indicates that production of cotton in Iraq is increasing gradually but is still far below prewar. The area planted to improved American-type Acala cotton, however, is increasing and the quality of the crop improving. Production for the current season is tentatively estimated at 5,000 bales against 4,000 bales last season, and 12,000 in 1938-39. Efforts are being made by the Director of Agriculture to induce farmers to increase the production of cotton. Returns from competing crops have been made in this direction. Among specific measures suggested to stimulate increased plantings of cotton are proposals for the exemption of farmers from a 10 per cent. sales tax on cotton and free distribution of planting seed. Prior to the erection of a cotton mill in Iraq in early 1948, consumption of cotton was confined to households. Consumption in 1948-49 is estimated at about 5,000 bales. In the past all of the American-type cotton was exported and small quantities of short-staple cotton imported from India for household use.

326. JAPAN: COTTON SPINDLEAGE. (*Cotton*, M/c., 5/3/49.) It is estimated that Japan's installed spindleage will reach 3,600,000 by the end of March, and 4,100,000 twelve months later, when it is hoped that 80 per cent. of the spindles in place will be in operable condition. The latest returns indicate that Japan still has less than 2,500,000 spindles actually in operation, representing rather less than three-quarters of those in place and rather more than three-quarters of those in working order. According to official returns issued by the International Federation of Master Cotton Spinners' Associations, in 1938 Japan's raw cotton consumption in season 1937-38 amounted to 3,660,000 bales of which 1,221,000 bales were American cotton, 1,675,000 bales of Indian cotton, 96,000 bales Egyptian cotton and 668,000 bales other growths. Japan's spindleage in 1938 totalled 12,550,000.

327. COTTON INDUSTRY. (*Cotton*, M/c., 28/5/49.) Advices from Tokio state that although the cotton industry's rehabilitation goal is set at 4 million installed spindles by the end of 1949, only about $2\frac{1}{2}$ million are currently in operation. While the Government still handles the importation of all raw cotton and maintains strict control over its distribution, it is expected that this responsibility will be turned over to private hands before the end of 1949.

328. Mexico: Crop Prospects. (*Cott. and Gen. Econ. Rev.*, 14/4/49.) Growing conditions continue good for the new crop and average estimates of the total production exceed 650,000 bales. Ginning of the Matamoros crop should start in the first week of July with prospects of 250,000 bales. The Central Bank is taking the initiative to facilitate exports of both raw cotton and textiles. Domestic mills are suffering from a lack of sales and may reduce their consumption.

329. Mexico: Textile Production. (*Ambassador*, 3, 1949, p. 132.) Although Mexico possesses available domestic supplies of raw cotton, and her industry expanded swiftly during the wartime shortage of cotton, about 25 million pesos' worth of cotton cloth are imported every year. Modernization of machinery, and diversion of production from the present concentration on the cheap types of cloth (exported in quantity) are said to be the chief measures necessary to change this situation. Mexico's exports at present consist mainly of calico, and her markets are chiefly South America and South Africa, whose demands in this field are similar to her own. Mexican manufacturers made a start on the production of poplin but have been obliged to halt, because of the high costs involved. Britain, the United States and Canada are the sources of supply for machinery, dyes and accessories, and the problem of dollar exchange augments the basic difficulty of keeping costs as low as possible. Some idea of the rising cost of labour may be gained from the fact that a textile plant in Mexico City, which paid staff wages totalling 55 million pesos in 1946, had to pay over 200 million pesos in the current year. One man frequently attends only four looms, where modern looms such as those in operation in the United States only require one man to thirty-two automatic looms. Mexico gained dollars by exporting raw cotton, but this was done to such an extent that local mills were left with only very small supplies; this means that out-of-date machinery has, in many instances, been handling short fibres (for which it was not intended) because of the large exports of long-fibre cotton. The cheaper type of cotton fabrics, however, are protected by import tariffs, which make it difficult for foreign products to compete with domestic production.

The current cotton harvest in Mexico will yield about 428,000 bales, as against 485,000 bales harvested in 1947. Because of unusually large exports of raw cotton (11/48), Mexican textile plants have suffered from a shortage of fibre. This has resulted in a decline in cotton textile production so that estimates for the end of 1948 record an 8 per cent. decrease, to 50 million kg. The domestic sales of cotton textiles have also declined, because of a price increase that is set as high as 40·7 per cent. above the level of July, 1947. As the textile industry is third in national importance in Mexico (exceeded only by mining and oil production), it is of primary importance for it to be modernized as speedily as possible. Many new mills are being constructed in an effort to keep Mexico's prominent place in Latin American cotton textile production, and when these are in operation it is considered likely that production costs may be halted, and the present dependence on foreign supplies greatly reduced.

330. Peru: Cotton Crop. (*Cotton*, M/c., 7/5/49.) Advices from Lima dated 4th April state that the crop is proving to be early, and cotton has already been received in small quantities from the Supe, Huacho, Canete and Chincha valleys. Reports as to the condition of the harvest are somewhat conflicting; it would appear that the Tanguis crop in some areas has been adversely affected by pests, but more water in the Piura River gives every prospect of a good Pima crop.

331. Portugal: Cotton Industry. (*Cott. and Genl. Econ. Rev.*, 20/5/49.) The cotton textile industry in Portugal continues to expand and is now consuming about 160,000 bales annually as compared to about 90,000 bales prewar. According to official statistics the industry has about 660,000 spindles and 24,520 looms in operation in 1946. The use of private capital with Government protection has developed the cotton textile industry in Portugal into one of the country's leading industries. Since the end of World War II Portugal has been meeting increased competition for export markets, but the steady development of exports to the Portuguese colonies where protective laws prevail has provided a ready market for

most of Portugal's surplus production. Before the war these colonies purchased most of their cotton textile supplies in Japan and the United Kingdom.

In the development of the cotton textile industry it has long been the aim of the Portuguese to utilize their colonies of Angola and Mozambique as the principal source of raw cotton. Their success is shown by the fact that whereas in 1934 only 12 per cent. of the cotton imported into Portugal was received from the colonies, in 1947 such imports were nearly 85 per cent. of the total.

332. SOVIET TEXTILE INDUSTRY: DEVELOPMENT. (*Kunstseide u. Zellwolle*, **26**, 1948, p. 123. (In German.) From *J. Text. Inst*, **40**, 3, 1949, p. A136.) It is stated that the Soviet textile industry, which uses exclusively home-produced raw materials, is constantly improving the quantity and quality of its production. It is expected that by the end of the present five-year plan the textile production will have doubled as compared with 1945. Ten photographs taken in Soviet textile mills are shown.

333. COTTON CULTIVATION IN SOVIET TURKMENIA. By P. Skossyrev. (*Kunstseide u. Zellwolle*, **26**, 1948, p. 102. From *Summ. Curr. Lit.*, xxix, **9**, 1949, p. 143.) A general description is given of the Murgab valley in Soviet Turkmenia (north-west of Afghanistan) and reference is made to the cultivation and breeding of cotton (including long-staple and coloured varieties) in this rich cotton area. The yield per acre has been more than doubled in the past twenty years. A map of the area is provided.

334. SPAIN: COTTON CROP. (*Cott. and Genl. Econ. Rev.*, 11/2/49.) According to the first official reports on the 1948 domestic cotton crop, yields have been very satisfactory. Production is estimated at around 7,000 tons. Of this production, 5,508 tons were American-type and 1,492 tons Egyptian-type. Excellent results were obtained in the arid zones of Andalucia, where the average yield per hectare reached 1,000 kilos. The past season can be considered the most encouraging since cotton growing was started in Spain, and although the quantity produced represents only a small percentage of the raw material requirements of the domestic textile industry, a continuation of the same enthusiasm should be reflected in a continuation of the upward trend and the early attainment of an annual outturn of 25,000 tons—*i.e.*, approximately a quarter of normal raw cotton needs.

SOIL, SOIL EROSION AND FERTILIZERS

335. AFRICAN CONFERENCE ON LAND POLICY. (*Crown Col.*, April, 1949, p. 208.) The Secretary of State for the Colonies has invited the Governments in East, West and Central Africa to meet in Nairobi in June to discuss stock policy and the control of their lands. It is intended that observers from other Powers with African responsibilities should be present. Southern Rhodesia, South Africa, Belgium, France and Portugal are to be invited to send observers. Another conference will be held in Jos a little later in the year, mainly to consider the mixed farming which might be possible with the discovery of the new drug, Antrycide.

In a parliamentary debate on soil erosion in East and West Africa, Mr. Rees-Williams, Under-Secretary of State for the Colonies, said that there was no more important subject than soil erosion, not merely for the Colonial Empire but for the people of the world. The Government proposed to tackle the problem in five ways. The first was the extension of contour terracing. The second was the conservation of rainfall and proper irrigation. The third method was by the control of stock generally, and cattle and goats in particular. Up to the present there had been little incentive for the African to sell his cattle at an economic price. The Government of Kenya was erecting an abattoir and a factory which, it was hoped, would use the whole animal. The fourth method was forest conservation; the fifth was soil conservation by good husbandry and methods of improved cultivation. A £1,500,000 scheme to build up a soil conservation service over the next ten years was started in Kenya in 1946.

336. COTTON CROP YIELD IN RELATION TO APPLICATION OF FERTILIZERS. By M. El Hineidy and F. Allam. (*Nature*, 5/3/49, p. 362.) In this experiment foliar

analysis of cotton (variety Menoufi) was used as an index to the nutrient conditions and crop yield of the plants. The soil plots used were loamy in texture, situated in the farm of the Faculty of Agriculture, Fouad I University, at Giza, and have been under five controlled treatments since 1932. The results indicate that addition of any fertilizer gave better yield than that of plants grown in the completely unfertilized plots. It must be remembered, however, that the soil of the untreated plots had been without any fertilizer application since 1932. The plants grown in plots supplied with full manure of phosphorus, potassium and nitrogen gave a higher yield than that obtained from plants given phosphorus and potassium but no nitrogen fertilizer. Non-addition of potassium or phosphorus fertilizer seemed to have very little effect on the crop yield. The results also showed that the Egyptian soil contains relatively large amounts of unavailable phosphorus and potassium, but little nitrogen; hence the need for addition of nitrogen fertilizer alone. The authors believe that the most suitable nitrogen fertilizer would be ammonium sulphate, because the ammonium-nitrogen would soon be transformed into nitrate by means of the nitrifying and nitrating bacteria which are usually abundant in Egyptian soil fit for cultivation. In the meantime the sulphate ion would help to neutralize the alkalinity of the soil (the *p*H of the soil being usually about 8·0), and in so doing render available some of the naturally occurring unavailable phosphorus.

337. Cotton Plant: Response to Nitrogenous Fertilizers. By W. R. Paden. (*Soil Sci. Soc. Amer. Proc.*, **12**, 1947, p. 289. From *Summ. Curr. Lit.*, xxix, **10**, 1949, p. 173.) The average yields of seed cotton on unlimed and limed plots which did not receive any fertilizer were 65·5 and 63·8 per cent., respectively, of the yields obtained from the corresponding plots which received sodium nitrate, superphosphate and potash. The yields from the unlimed and limed plots which received only superphosphate and potash were equal to 69·4 and 64·6 per cent., respectively, of the plots which received sodium nitrate in addition. The yields from calcium nitrate, fish scrap, tankage, and ammonium sulphate were slightly higher on the unlimed plots than sodium nitrate; whereas the yields from the calcium cyanamide, cottonseed meal, urea, Ammophos, and Milorganite were lower, in the order named. On the limed plots the yields from all sources were slightly higher than those on the unlimed plots. Such acid-forming sources of nitrogen as Ammophos and ammonium sulphate lowered the amounts of exchangeable Ca in the soil with corresponding increases in the amounts of exchangeable H. Plots which received sources containing Ca and Na, such as calcium nitrate, calcium cyanamide, and sodium nitrate, had higher amounts of exchangeable Ca and lower amounts of exchangeable H. The amount of exchangeable Ca may be reduced to the extent that a deficiency of Ca is likely to occur.

338. Animal Excreta in the Sudan Gezira. By T. N. Jewitt and H. W. B. Barlow. (*Emp. J. of Exper. Agric.*, xvii, **65**, 1949, p. 1.) This paper describes a series of experiments bearing on the amount and availability of animal manure in the dry and irrigated parts of the Sudan Gezira. Special emphasis is placed on the influence of the diet on the effectiveness of the manure, and on the paramount importance of the urine. Responses to animal manure have been measured in pots and in the field. Collections of dung and urine have been made from penned animals, and laboratory tests done on the rates of nitrification of such excreta. Dungs have been collected from many sites in the field, and the amounts deposited per year have been estimated; from these data deductions have been drawn as to the potential value of the animal manure in the region.

STATISTICAL TREATMENT, CULTIVATION, GINNING, ETC.

339. Laying Off Rows by the String Method. By J. F. Doggett and T. L. Copley. (Nth. Carol. Sta. Coll. Agric. and Eng., Ext. Cir. No. 329, 1948.) A system of laying off rows for better drainage and less soil loss has been tested and perfected at the Soil Conservation Experiment Station near Raleigh, North Carolina. It is practicable for all row crops on terraced land. The purpose of this new way

of laying off rows is to make each row carry its own water with moderate grade. When this is done, each row acts as a small terrace. To accomplish this, the rows must run parallel with the upper terrace when the interval between terraces is narrowing and parallel to the lower terrace when the interval is widening. Additional fall must be given at any points where needed. The method for laying off rows described in this circular is known as the "string method" because string is generally used in locating the guide row. The circular is illustrated with many useful diagrams.

340. An Experimental Design used to Estimate the Optimum Planting Date for Cotton. By R. L. Anderson and H. L. Manning. (*Biometrics*, 4, 3, 1948.) This paper presents a new type of experimental design, the "staggered" design, for use with experimental material which can have but few consecutive plantings at a given locality. Two experiments involving the determination of the optimum planting date of cotton have been conducted in British East Africa. The "staggered" design was used because of a fear that an insect, *Lygus simonyi*, would tend to transfer from earlier planted plots to newly planted ones, hence distorting a proper assessment of the relationship between cotton yield and planting date. At one of the experiments, an index of the Lygus damage was determined for each plot. If this index truly reflected the Lygus damage, it appeared that there was no important migration for planting dates separated by four weeks or less. The authors have shown that the 3-date "staggered" design is decidedly inefficient in estimating the optimum planting date. The adjustments for locality effects are so great that there tends to be a very long range of indeterminacy of the optimum planting date. The following suggestions are offered to improve the efficiency of the estimation of the optimum planting date under conditions of uncertainty with respect to insect migration: (i) Test the adequacy of the Lygus damage index as a true indicator of the infestation by the Lygus bug. If this index is reliable, or can be made reliable, then it would appear that more planting dates should be used at each locality and that adjustments should be made for the Lygus damage by covariance techniques rather than by use of the "staggered" design. (ii) Even if the index is shown to be inadequate, especially when more than 3 planting dates are used at each locality, it is recommended that 4 successive planting dates at each locality should be tried. (iii) A great improvement would result if the localities did not differ so widely in their fertility. This "staggered" design would be much more efficient if the locality differences were not so pronounced as in the African experiments. (iv) It is advisable to plan the experiment so that the optimum planting date is near the middle date used in the experiment. (v) Ordinarily the experimenter hopes to secure some information on the correct allocation of experimental material as to changes in the number of locations and replications within locations. In this case the small date-location interaction as compared to the date-replication interaction leads to the inference that no information could be lost by the use of fewer localities and more replications at each locality. Since this result was obtained in both experiments, it is felt that the use of more planting dates at a given locality with fewer localities being used probably would not materially alter the error variance.

341. The Effect of Pre-planting Irrigation on Pathogenicity of *Rhizoctonia solani* in Seedling Cotton. By G. Staten and J. F. Cole. (*Phytopathology*, xxxviii, 8, 1948, p. 661. From *Rev. of App. Myc.*, xxviii, 2, 1949, p. 65.) At the New Mexico Agricultural Experiment Station partial control of *Rhizoctonia solani* on cotton was effected by giving the seed-bed an irrigation three weeks before planting and thereby allowing antagonistic fungi a long incubation period. Thus, in a lightly irrigated double-row bed the mean percentage of post-emergence damping-off was 2·23 compared with 11·69 in a non-irrigated flat bed, the corresponding figures for the heavily irrigated and non-irrigated beds being 4·57 and 14·50, respectively. In a greenhouse experiment, using acid-delinted, ceresan-treated Acala 1517 seeds, the damping-off in field soil with added inoculum (ground, air-dried seedlings killed by the fungus, 2·5 gm. per pot) was reduced from 40·98 to

26·28 per cent. by pre-planting irrigation. These results suggest the partial inhibition of *C. solani* by antagonistic or competitive organisms in soil irrigated before planting. Some degree of control may be secured in rainfall areas by early seed-bed preparation when soil moisture is present.

COTTONSEED AND COTTONSEED PRODUCTS

342. COTTONSEED PROTEIN DISPERSIONS: PREPARATION AND PROPERTIES. By J. C. Arthur and M. K. Karon. (*J. Amer. Oil. Chem. Soc.*, **25**, 1948, p. 99. From *Summ. Curr. Lit.*, xxix, **9**, 1949, p. 144.) An investigation has been made of methods for preparing non-gelling dispersions of cottonseed proteins in high protein concentration which have good tackiness and desirable viscosities for industrial use. The properties of isolated cottonseed protein depend on (1) the method of isolating the protein, (2) the concentration of proteins in the dispersion, (3) the concentration of sodium hydroxide used to disperse it, and (4) the action of trichloroacetate ion to prevent gelation. A method is described for preparing non-gelling, tacky dispersions of cottonseed protein in which trichloroacetate ion has been used to prevent gelation.

343. COTTON LINTERS: REFINING. (Sous-Commission Scientifique du Raffinage. *Mém. Serv. Chim. État.*, **33**, 1947, p. 107. From *Summ. Curr. Lit.*, xxix, **10**, 1949, p. 173.) Further studies are reported in conclusion of a previous paper dealing with the effect of refining on the fibre length, the degree of polymerization and the rate of hydrolysis of cotton linters, and on the reactivity of the cellulose hydroxyl groups. The results show that the chemical composition of the linters remains practically unchanged for any length of refining, that no perceptible amount of organic matter is dissolved and that there is no evidence of inter-fibrillar cementation. The physical effect of refining consists of cutting the fibres and dissociating them into fibrillar elements, increasing the surface, and increasing the number of hydroyxl groups which can intervene in the formation of the sheet of paper.

MACHINERY

344. LABORATORY GINS AND TESTS OF RELIABILITY OF GINNING WITH DIFFERENT SIZES OF SEED COTTON LOTS. By A. J. Johnson and Z. M. Looney. (U.S. Dept. Agric. Circ. No. 782, 1948, p. 13. From *Pla. Bre. Abs.*, xix, **1**, 1949, p. 121.) A report is given of tests carried out to determine the minimum quantity of seed cotton necessary to obtain a reliable lint out-turn from various small laboratory gins now in use by breeders and agronomists.

345. REPORT OF THE PROCEEDINGS OF THE SECOND ANNUAL BELTWIDE COTTON MECHANIZATION CONFERENCE, OCTOBER, 1948; LUBBOCK, TEXAS. Nat. Cott. Council of America, pp. 113.) This comprehensive report contains more than twenty addresses dealing with the various aspects and problems of cotton mechanization in the United States cotton belt. Plant breeding, defoliation, mechanical picking and stripping are discussed, and the impact of mechanization on ginning and spinning is noted.

PESTS, DISEASES, AND INJURIES, AND THEIR CONTROL

346. PLANT PROTECTION SERVICE IN THE UNITED PROVINCES. By K. B. Lal. (*Ind. Frmg.*, ix, **12**, 1948, p. 493.) The Government of the United Provinces are the first among Provincial and State Governments in India to establish a Plant Protection Service on a planned basis. This service, which is meant to control agricultural pests as well as diseases, started functioning in August, 1947, with the following main objects: (1) To organize large-scale control operations against crop and other pests and diseases in different areas of the province. (2) To maintain a regular watch and ward service for the detection of pest and disease attacks on crops, fruit trees, etc., with a view to simplifying future measures of control. (3) To prevent the entry and spread of agricultural pests and diseases within the province.

(4) To demonstrate to the satisfaction of the cultivators the effectiveness of certain measures to control pests and diseases and to impress upon them the advantages accruing out of the control measures. (5) To render practical assistance to farmers to fight pests and diseases and thus to raise more and better crops, and to save stored crop produce from damage. A plant protection service is a new development, if not exactly a new conception, in India. The working of such a service in the United Provinces has revealed many problems of technique, organization and policy. This article gives an account of its beginnings for the benefit of those who contemplate the establishment of similar services in other areas.

347. EGYPTIAN COTTON: EFFECT OF BOLLWORMS ON QUALITY AND GRADE. By I. Bishara. (*Egyptian Cott. Gaz.*, 6, 1949, p. 49.) A study has been made of the depreciation in the quality and grade of cotton subjected to bollworm attack. The investigation was started in 1943 and tests have been carried out on six varieties of cotton grown on an experimental field in such a way that samples varying in degree of infestation could be compared with ordinary commercial samples. Results are presented in graphs which show the decrease in yarn strength, staple length and hair weight with increased infestation and indicate a continual rise in bollworm attack with every drop in grade.

348. THE HELIOTHIS CATERPILLAR (*Heliothis armigera*). By W. L. Morgan. (*Rev. App. Ent.*, 37, A, 2, 1949, p. 42.) Larvæ of *H. armigera*, the bionomics of which are briefly described, attack a wide range of cultivated plants, but can be controlled on all of them with sprays and dusts of DDT. Since they pupate in the soil and moisture favours the rapid emergence of the adults, control treatments should, in many instances, be applied to crops within 10-14 days of rainfall heavy enough to wet the soil to a depth of 3-4 inches. A 0·1 per cent. DDT spray or a 2 per cent. DDT dust, the former either as an emulsified solution or as a suspension prepared from a dispersible powder, can be applied to most flowers and vegetables. On tobacco, a 0·1 per cent. spray or a 1 per cent. dust should be applied at intervals of 2-4 weeks, particularly to the growing tip and top growth. Stone and pome fruits should be sprayed with 0·05 per cent. DDT. Lucerne seed crops and flax should be dusted with 5 per cent. DDT at the rate of 15-20 lb. per acre, applied by means of a powder duster or from an aeroplane about a week after the crops are in full flower, or a spray containing about 2 lb. dispersible DDT in 2-6 gals. water can be applied as an aerosol from a machine designed for the application of concentrated insecticides. The larvæ can be controlled in maize by treatment of the individual ears with a 5 per cent. DDT powder or a few drops of white mineral oil, which should be applied to the silks about five days after they appear, but this is expensive. Areas cropped with maize should be ploughed or harrowed in winter to destroy the pupæ.

349. JASSID RESISTANCE AND HAIRINESS OF THE COTTON PLANT. By F. R. Parnell, H. E. King and D. F. Ruston. (*Bull. Ent. Res.*, 39, 4, 1949, p. 539.) A wide range of material has been studied in an investigation of the relationship between "resistance" to attack by *Empoasca facialis* and "hairiness" of the cotton plant. A continuous range has been found between full susceptibility and very high resistance. In general, relative susceptibility as gauged by visual assessment of symptoms has been found to correspond closely with relative infestation, determined by counts of nymphs. With attention confined to grown plants, the *relative* susceptibility of varieties has been found substantially constant under varying levels of exposure to infestation. Hairiness of the cotton plant has been found to show an extremely wide range in degree, style and distribution. A method has been devised for expressing hairiness numerically, taking into account both length and density of hairs. A very close and consistent relationship has been found between degree of hairiness of the under surface of the leaf, and degree of resistance to Jassid. Without exception, all thoroughly hairy types have been found highly resistant, and all non-hairy types fully susceptible. Intermediate degrees of hairiness are associated with intermediate degrees of resistance. The relationship has been found to hold good between varieties and between plants within varieties, of the species *G. hirsutum*;

also between plants of *G. barbadense*, and in segregating progenies of hybrids between these two species. The hairiness of resistant strains of cotton has been found to develop gradually with the growth of the plant; the first few leaves on the seedlings being virtually non-hairy. This lack of hairiness in the early stages of growth is associated with a lack of resistance. Hairiness and resistance to Jassid develop concurrently.

The conclusion is reached that hairiness of the leaf *confers* resistance to Jassid and that degree of leaf hairiness, measured in an appropriate manner, is a thoroughly reliable guide to degree of resistance. Length of hairs is shown to be of prime importance, and high densities without adequate length are ineffective. The relative importance of hairs on lamina and midrib has not been conclusively determined. Both have an influence on resistance, but a high degree of midrib hairiness is not essential if the lamina is hairy. Hairs on stem and petiole are shown to be of very little importance.

350. *Pectinophora gossypiella* SAUND. By M. Kaussari. (*Ent. and Phytopath. Appl.*, 2, 1946, p. 9. From *Rev. Appl. Entom.*, 37, Ser. A, 1, 1949, p. 10.) Enquiries have shown that *Platyedra* (*Pectinophora*) *gossypiella*, Saund., which was recorded on cotton at Bandar Abbas in southern Persia in 1937, was originally imported in cottonseed from Egypt in 1934. It has not spread beyond a few localities in southern Persia, owing to the limited extent to which cotton is grown there, the extensive deserts and high mountains that separate Bandar Abbas from the other cotton-growing districts, and the control measures taken; most of the cottonseed produced in the area is fed to cattle. The fact that up to four larvæ have been found in single bolls suggests that the insect is not attacked by parasites in Persia. Subsequent investigations showed that it was also present in Charbar, where it was probably introduced in cottonseed from India.

351. SUDAN BOLLWORM: CONTROL BY PLANT TRAPS. By A. H. McKinstry. (*12th Ann. Rpt. Cott. Res. and Indus. Bd.*, Sthn. Rhodesia, 1947-48. Received 1949.) At the Cotton Research Station, Gatooma, in the season 1946-47, crop damage was due almost exclusively to Sudan bollworm. When the first flower squares were being produced, larvæ were recorded at the rate of one per plant, and about 10 per cent. of the locks of mature bolls showed damage due to bollworm punctures. Counts of overwintering pupæ in unploughed cotton lands in July and August showed that there were 2,000-3,000 Sudan bollworm pupæ per acre, the vast majority of them being found in the uppermost 4 inches of the surface soil. Similar counts in the winter months of 1946 revealed overwintering pupæ populations of about 24,000 per acre. It is emphasized that control measures which reduce Sudan bollworm damage in the early crop will probably result in an appreciable and lasting increase in the main yields of seed cotton per acre. To this end the following experiments are in progress. Photoperiodic perennials, at present represented only by a small number of plants of a mixed type known as Ecuador 5, are being tested as plant traps for the early Sudan bollworm egg laying in the November-January period. Fairly heavy egg-laying took place on them this season, as at this period the plants, in their second year of growth, were vegetative. No larvæ developed fully, though small ones were seen, until the plants commenced to bear large buds and young bolls in April and May. Propagation of Ecuador 5 is in progress, quite a number of bolls having been obtained from the few plants despite the fact that fruiting occurred in the winter months, but an immediate expansion in the use of Ecuador 4 or other photoperiodic cottons as plant traps for the early Sudan bollworm egg-laying is not contemplated until further experience has been gained in the management of a larger number of plants at the station.

352. LOCUST CONTROL. (*Corona*, 1, 4, 1949, p. 6.) The United Kingdom, Belgium, South Africa and Southern Rhodesia have signed a Convention to establish the International Red Locust Control Service on a formal basis. An International Council is to be set up with headquarters at Abercorn in Northern Rhodesia. The informal Control Service has been established for some years in southern Tanganyika and has been studying and controlling the outbreak areas in the Rukwa Valley and

the Mwere-Wantipa marshes. It carried out a spectacularly successful campaign in 1948 when an outbreak of great potential severity for the whole of eastern and southern Africa was completely stamped out in a four-months campaign. The main method used was the spraying of Gammexane from hand-pumps.

353. LOCUST CONTROL IN INDIA. By H. S. Pruthi. (*Sci. Rep. Agric. Res. Inst. New Delhi*, 1944-45, Delhi, 1946, p. 80. From *Rev. App. Entom.*, **37**, Ser. A, 1, 1949, p. 30.) As a result of the control measures adopted by the Indian anti-locust organization in India and in the monsoon breeding areas in the Persian Mekran and Oman, India was free from swarms of locusts (*Schistocerca gregaria*, Forsk.) from November, 1943, until March, 1944, when a fresh invasion began from the north-west. Breeding had not occurred in Persia or Oman, but had taken place actively in the Sudan, East Africa and the Red Sea Coast. Swarms continued to arrive during April. Eggs were laid in Baluchistan, where most of the resulting hoppers were controlled by June, and also in Sind, where some adults matured in spite of control measures. Further immigration from the west into Sind and Rajputana occurred in June, and one small swarm reached the Central India States and another, Cutch State, in the middle of July; the United Provinces were not invaded. Swarms developed all over the desert tracks of Sind-Rajputana and the southern Punjab, and young cotton was slightly damaged in some parts of Sind and the Punjab. Eggs were laid in July in almost all the States and monsoon breeding occurred in Baluchistan for the first time during the present cycle, but practically all the resulting swarms were controlled. Two or three developed, however, and migrated to the Punjab and Sind, where, in October-November, they produced a very small second generation, which was destroyed. Fresh swarms developed in Arabia and on the Red Sea coasts early in 1945, and Baluchistan was invaded in late March and April by swarms moving across Persia and Afghanistan. Extensive oviposition took place in northern Baluchistan, but almost all the hoppers that hatched out there were destroyed. Many of the swarms, however, migrated on into the Punjab and the North-West Frontier Province, where eggs and hoppers were reported from several localities in May, and one entered the United Provinces. Immature locusts continued to invade British Baluchistan during May.

354. A CATALOGUE OF INSECTICIDES AND FUNGICIDES. Vol. II. CHEMICAL FUNGICIDES AND PLANT INSECTICIDES. By D. E. H. Frear. (Chron. Bot. Co., Waltham, Mass., 1948. Price $5.50. From *Rev. App. Myc.*, xxviii, **4**, 1949, p. 183.) In the second volume of this valuable compilation, the system of code numbers used in the first is given again, and the same arrangement followed. It comprises chemical fungicides, condensation products, fungicides from plant products, miscellaneous fungicides, insecticides from plants, miscellaneous plant products, references and author index, a numerical patent list, and an index of the chemical compounds in both volumes. It has been the author's aim to bring together all the published results on tested materials up to January, 1944.

355. AN OBSERVATION ON THE RELATIVE VALUES OF SEVERAL GENERAL INSECTICIDES. By A. P. G. Michelmore. (*E. Afrn. Agric. J.*, xiv, **3**, 1949, p. 136.) Observations of dead and dying insects and other arthropods were made in a series of young cotton plots treated with insecticides for another purpose. The insecticides were: (i) diluted pyrethrum dust applied at the rate of 8 lb. pyrethrum per acre; (ii) a BHC aqueous spray giving 0·24 lb. gamma isomer per acre; (iii) a BHC dust giving 0·1 lb. gamma isomer per acre; (iv) and (v) two aqueous sprays of DDT giving 1·5 lb. DDT per acre; and (vi) a DDT dust giving 1·26 lb. DDT per acre. With both BHC and DDT a spray killed more of almost any group than a dust, but it was somewhat more expensive to apply. At the strengths used, BHC proved definitely superior to DDT as a general field insecticide and also against every single group found except the Diplopoda. The BHC spray killed the most but burned the leaves, and should be used more sparingly, when it would probably be about as efficacious as the pyrethrum, which came second in killing power. The BHC dust was distinctly less effective than the pyrethrum and cost much more. Pyrethrum was specially toxic to Coccinellidæ, while Araneida, Diplopoda and Orthoptera

showed signs of resistance to it. Coccinellidæ were killed only in small numbers by the other insecticides. Considerable numbers of terrestrial insects were killed, especially by the sprays. The latter result is believed to have been due more to the method of application than to the inherent toxicity of the sprays. Beneficial, harmful and indifferent creatures were killed, but there was no evidence of a harmful disturbance of the balance of nature during the period of the trial.

356. 2,4-D Injury to Cotton from Airplane Dusting of Rice. By A. A. Dunlap. (*Phytopathology*, xxxviii, 8, 1948, p. 638. From *Rev. App. Myc.*, xxviii, 2, 1949, p. 64.) During the summer of 1947 cotton in the Gulf Coast area of Texas sustained heavy damage, resulting in a total loss of crop over an area of 2,000 acres, from the dusting of adjacent rice fields by aeroplane, during the latter part of May and the first week of June, with herbicidal mixtures containing about 10 per cent. of various salts or esters of 2,4-dichlorophenoxy-acetic acid. The injury took the form of foliar and floral distortions, rupture of the stem cortex and basal swellings. Partial recovery of the affected plants, as shown by the production of normal foliage and fruiting structures, occurred in most fields where favourable conditions for growth prevailed during the rest of the season. Seed collected from such plants, however, germinated only 40 to 60 per cent. and produced seedlings with swollen root tips and other abnormalities. Some measures are proposed for the prevention of damage to susceptible crops from weed-killers containing 2,4-dichlorophenoxy-acetic acid.

357. The Effect of Insecticides on the Respiration of *Oryzœphilus surinamensis*: An Attempt to Compare the Speeds of Action of a Number of DDT Analogues. By K. A. Lord. (*Anns. of App. Biol.*, 36, 1, 1949, p. 113.) A method has been devised for observing the effects of a number of non-volatile contact poisons on the oxygen uptake of groups of *Oryzœphilus surinamensis*. Toxic concentrations of DDT and of its analogues applied as dusts to *O. surinamensis* increase the rate of oxygen uptake; sublethal concentrations appear to have no effect. The total oxygen uptake of groups of starving *O. surinamensis* appears to be constant, whether or not they are treated with DDT or its analogues. In each case a linear relationship appears between length of life and total volume respired before death. The stimulus of DDT to *O. surinamensis* is apparently quantal and the magnitude is independent of the concentration of DDT in the dust. The stimuli resulting from the action of DDT and its analogues are approximately equal, as are the rates at which the insects die. There is, however, apparently a correlation between molecular weight and length of life—*i.e.*, there is a tendency for the insects treated with the poisons of lower molecular weight to die more rapidly than those treated with the analogues of high molecular weight. The effect of benzene hexachloride on the respiration of *O. surinamensis* has been shown to be similar to that of DDT. The effects of a number of insecticides on the oxygen uptake of *O. surinamensis* have been compared. As a result the insecticides have been classified in two groups: (*a*) those stimulating respiration—*e.g.*, DDT, BHC, pyrethrins; (*b*) those depressing respiration—*e.g.*, rotenone, Lethana B 71.

358. Residual Toxicity of Chlorinated Hydrocarbon Insecticides. By B. K. Petty. (Dept. Agric., Union of S. Africa, Science Bull. No. 291.) An outstanding property of DDT and other chlorinated hydrocarbon insecticides, notably benzene hexachloride, chlordan, chlorinated camphene and pentachlorophenol, is their prolonged residual toxicity when applied under practical conditions. It is well known, however, that the persistence of DDT residues varies according to the type of surface to which it is applied, the effect being very much more prolonged on some surfaces than on others, and it was considered probable that this would apply to other chlorinated hydrocarbon insecticides as well. Investigations have been carried out to determine the most suitable formulations for each insecticide for use on different surfaces—namely, enamel, distemper, wood, glass and filter paper—in order to obtain the highest degree of insect control; and a project has been instituted with the object of developing a technique for the biological assay of these insecticides on different types of surface. This work is essentially a long-term project involving

the determination of the relative duration of residual effectiveness of oil solutions, dusting powders, smokes, water suspensions and emulsions, and will take several years to complete. It is considered advisable, therefore, to publish the results of certain tests already completed as a progress report rather than to wait until finality has been reached on the whole project, since some of the results may be of interest and possible value to those engaged on similar lines of work.

359. Cotton Boll Weevil, *Anthonomus grandis* Boh., and Cotton Aphid, *Aphis gossypii* Glover: Control by Chlorinated Camphene and Parathion. By H. D. Loden and H. O. Lund. (*J. Econ. Ent.*, **41**, 6, 1949, p. 851.) Chlorinated camphene and parathion dusts were tested against the cotton boll weevil and the cotton aphid in small-plot field experiments. Chlorinated camphene appears to maintain a residual killing power for the boll weevil for over three weeks, but neither chlorinated camphene nor parathion appears to exert any significant residual killing power against cotton aphids after one week. When chlorinated camphene and parathion were applied at weekly intervals, no significant aphid populations developed. Regular weekly applications of calcium arsenate and chlorinated camphene appear to be about equal in their final effect upon the boll weevil populations, but the chlorinated camphene effects the control more rapidly. Parathion in the 1 per cent. concentration is now effective against the boll weevil. Chlorinated camphene, DDT-benzene hexachloride and calcium arsenate containing 2 per cent. nicotine sulphate are approximately equally effective in reducing already high aphid infestations, but parathion is far superior to any of these. Yields of the plots treated weekly for 6 weeks with chlorinated camphene were satisfactorily superior to all others except the calcium arsenate plots, but the calcium arsenate plots were not significantly superior to any others.

360. A Technique for Determining the Stomach Poison Effect of Insecticides Used against Leaf-eating Insects. By M. J. Way. (*Anns. of App. Biol.*, **36**, 1, 1949, p. 86.) Methods devised for feeding individual insects with leaf areas bearing known deposits of insecticides are described, and the problems associated with incomplete consumption of the treated leaf proportions are discussed. An account is given of the difficulties of applying the technique to small insects and to those with erratic feeding habits. Experimental data are given to illustrate the effects on insect resistance of the following: (1) Rearing conditions, (2) larval age and body weight, (3) acute and chronic poisoning, (4) the diluting effect of the leaf tissue consumed with the poison dose. The dosage mortality curve for stomach poisons was found to be typically sigmoid: analysis of results by the method of probits (Bliss, 1934) therefore proved satisfactory. Using lead arsenate against fifth-instar larvæ of *Phlogophera meticulosa* the ratio of weight increase to increase in median lethal dose was found to be constant.

361. Tetraethyl Pyrophosphate as an Insecticide. By C. Potter. (*Nature*, 5/3/49, p. 379.) The shortage of nicotine for use as an insecticide has stimulated the search for suitable substitutes. One of the organic phosphorus insecticides called hexaethyltetraphosphate (H.E.T.P.) seemed to fulfil many of the requirements; but more recent research has indicated that tetraethyl pyrophosphate (T.E.P.P.) is responsible for the major part of the insecticidal activity of the former, and that an insecticide containing a high percentage of T.E.P.P. was desirable. Messrs. Albright and Wilson have available an insecticide containing 50 per cent. T.E.P.P. as compared with the 20 per cent. contained in H.E.P.T. T.E.P.P. is a mobile liquid, miscible with water and most common organic solvents; it is not, however, freely miscible with petroleum ether or other paraffin hydrocarbons. In the absence of moisture it is a stable compound, but it hydrolyses rapidly in the presence of water. It is hygroscopic. It is said to be compatible with a variety of insecticides and fungicides; but it should not be used with alkaline materials. It may be applied as a spray or as an aerosol. In the concentrations used it exhibits very little phytotoxicity. It lacks the fumigant effect of nicotine. T.E.P.P. is very toxic to warm-blooded animals, and the concentrates must be handled with great care. Its chief use in practice would appear to be for the control of aphids and thrips.

362. Disease in Tropical Crops. (*Nature*, 26/2/49, p. 332.) Commenting on the trend of diseases in tropical crops and the failure to offset their damage by a policy of breeding resistant varieties, Dr. C. D. Darlington writes: "Thus in cocoa as in all other British tropical crops (except cotton) the ideal solution, the fundamental solution, has still to be treated as a subsidiary matter of no urgency. And there is no plan for attempting it."

363. An Interesting Cotton Defoliation. By A. Ciccarone. (*Rev. Agric. Subtrop. Trop.*, xlii, 7-9, 1948, p. 154. From *Rev. App. Myc.*, xxviii, 2, 1949, p. 65.) During October, 1947, *Alternaria macrospora* caused severe leaf-shedding of cotton plants in Venezuela, especially of those in which the peduncles were attacked. Damage was especially evident in an indigenous planting. Seedlings of this indigenous cotton and of Coker 100 Wilt Strain 2 were inoculated when about 20 cm. high by puncture or with pieces of the cultured fungus placed on the peduncles. The puncture-inoculated native plants shed their leaves 11 to 12 days after inoculation and those inoculated with pieces of the fungus also showed positive results, but more slowly. The Coker strain proved much more resistant under the conditions of the experiment.

364. The Effect of Pre-planting Irrigation on Pathogenicity of *Rhizoctonia solani* in Seedling Cotton. See Abstract No. 341.

365. Periodic Partial Failures of American Cottons: their Causes and Remedies. By R. H. Dastur. (Ind. Cent. Cott. Comm., Sci. Mon. No. 2. Revised second edition. Price Rs. 6.) The first edition of this report gave detailed results of the investigations into the causes of the partial failures of American cottons in the Punjab due to *tirak* and red-leaf disease. These investigations were carried out at the Punjab Agricultural College, Lyallpur, from 1935 to 1942. The Sind-American cottons in Sind, since they entered into large-scale cultivation after the completion of the Lloyd barrage in 1932, have also been reported to suffer from the "bad opening" of bolls, although partial failures of crop have not occurred as in the Punjab. After the Punjab investigations were completed in 1942, investigations in Sind to determine the causes of "bad opening" were undertaken and completed in 1946. The same causes and the remedy for the disease discovered in the Punjab-American cottons were found to hold good for the Sind-American cottons in Sind. It was also explained why such partial failures of the cotton crop had not occurred in Sind. The main findings of the investigations conducted in Sind are now incorporated in this second edition. The factors that produce red leaf disease were also investigated. The two types of red leaf, the yellow-red and the green-red, have been differentiated, and these two types of red leaf have been found to be associated with two different types of soils.

366. Non-Susceptible Hosts as Carriers of Wilt Fusaria. By G. M. Armstrong and J. K. Armstrong. (*Phytopathology*, xxxviii, 10, p. 808. From *Rev. App. Myc.*, xxviii, 4, 1949, p. 189.) In studies at the South Carolina Agricultural Experiment Station on the function of non-susceptible hosts as carriers of wilt-inducing species of *Fusarium*, the plants were grown in soil, in solution-culture, and in steamed sand. Healthy sweet potato roots were shown to carry internally species of *Fusarium* of the section *Elegans* differing from those causing wilt of that host. Plants from these roots also contained *Fusarium* spp., presumably originating in the parent sweet potato. Cotton, either inoculated in the greenhouse or grown in a field infested by *F. oxysporum* f. 2, was invaded by this fungus without showing any symptoms of wilt and thus served as a carrier. Other symptomless carriers were *Cassia tora*, Mexican clover, okra, sage, soy-bean, and tomato, from all of which *F. oxysporum* f. 2 was re-isolated and successfully inoculated into sweet potato. A *Fusarium* causing tobacco wilt was re-isolated from inoculated *C. tora*, cotton, okra, sage, soy-bean, and *R. scabra*. Sweet potato plants were invaded by the agent of cotton wilt either from infected field soils or in greenhouse inoculations. Stem and root sections of cotton plants inoculated with *F. oxysporum* f. 2 from sweet potato were plated on potato dextrose agar to determine the location of the fungus in the host. It was recovered from the wood of the tap-root and the basal inch or stem,

and also from the bark of the latter, but not from the twelfth inch of the stem or upwards.

Mixed cultures of *F. vasinfectum* and *F. oxysporum* f. 2 were inoculated into cotton, and both species were re-isolated from wilting plants. The re-isolations frequently gave rise to V-shaped sectors with characteristics of one or other of the original cultures. Had it not been known that the inoculum was a mixed culture, these sectors might have been regarded as variants of *F. vasinfectum*. The results of these experiments clearly demonstrate the need for the use of monosporous isolates to determine host relationships.

GENERAL BOTANY, BREEDING, ETC.

367. ADAPTATION OF THE COTTON PLANT TO HIGH SOIL SALINITY. By B. P. Strogonov. (C. R. Doklady Acad. U.S.S.R. 1946, **54**, p. 435. From *Pla. Bre. Abs.*, xix, **1**, 1949, p. 120.) Reference is made to the adaptation of cotton plants to saline conditions, which is expressed externally by the bleaching of the chlorophyll in the isolated leaves treated with salt solutions, this test being a useful indication of the adaptation of different varieties. A study is reported of the influence of this adaptation upon the seeds—*i.e.*, upon the next generation. Cotton varieties grown on soils of varying salinity were used in the experiments. It is concluded from the results that seeds from plants grown under saline conditions and the plants which develop from these seeds do not show increased salt resistance.

368. COTTON PLANT: CULTIVATION ON SANDY SOIL; EFFECTS OF ARSENIC. By T. Coury and G. Ranzani. (*An. Excol. Super. Agr. Luiz de Queiroz*, **2**, 1945, p. 393. From *Summ. Curr. Lit.*, xxix, **9**, 1949, p. 143.) Sodium arsenite at 16 lb. per acre and lead arsenate at 48 lb. per acre reduced the vegetative development and the production of cotton on white sandy soil. The roots were more affected than the aerial parts. Sandy soils are particularly sensitive to arsenic toxicity.

369. HYBRID COTTON. By R. Balasubrahmanyan and N. Narayanan. (*Ind. Cott. Grwg. Rev.*, **2**, 3, 1948, p. 125. From *Pla. Bre. Abs.*, xix, **1**, 1949, p. 120.) Literature on heterosis in cotton is reviewed. Experiments are being carried out at the Cotton Breeding Station, Coimbatore, Madras, on the commercial possibilities of hybrid vigour in cotton. Interspecific crosses between *Gossypium hirsutum* and *G. barbadense* have been studied. In hybrids included in the irrigated series, heterosis was expressed as advantages in staple length, fibre weight and spinning value, but not in yield of seed cotton or ginning percentage. The results indicated that if hybrid vigour is to be exploited on a commercial scale, careful choice should be made of the parental type of *G. barbadense*. Under irrigated conditions, the single interspecific hybrid tested, *G. hirsutum* Co. 2 × *G. barbadense* Verdao, gave the very considerable yield of 2,210 lb. seed cotton per acre in small-scale trials; *G. hirsutum* Co. 2 and *G. barbadense* Verdao yielded 584 and 80 lb., respectively. In other qualities, particularly staple length and insect resistance, this hybrid also showed promise. In addition, success has been obtained in the vegetative propagation of cotton by the use of the hormones Seradix A and indol-B-acetic acid in root cuttings. It has not been possible to acclimatize or develop a long-staple cotton of the *G. barbadense* type in southern India; the production of hybrid cotton will meet the need for an extra long staple cotton of over 1¼ inch as an irrigated winter crop. All previous attempts to replace the pest-ridden perennial nadam cotton (*G. arboreum*) cultivated as an unirrigated crop on the poorer soils in certain upland areas of central districts by a hardy annual have failed. The production of suitable perennial hybrid cottons, vegetatively propagated, should provide a means of solving this problem.

370. INDIA: LONG-STAPLE COTTON. (*Cott. and Genl. Econ. Rev.*, 20/5/49.) An improved variety of long-staple cotton has been produced in the Bose Institute in Calcutta by an X-ray treatment and cross-breeding. It has a staple of 1·4 in. and flowers in 57 days instead of the 3 months normally taken. The yield is ex-

pected to be two and a half times greater than the present Madras or Lyallpur varieties, and this is attributed to the richness of the soil in Bengal.

The Government of Madras has sanctioned a scheme for the evolution of a suitable strain of long-staple American cotton for cultivation as a winter crop in the central districts, and to conduct trials of Sea Island varieties of cotton on the West Coast. The targets of the scheme are to evolve a strain of cotton of a staple length between $1\frac{1}{16}$ in. and $1\frac{1}{8}$ in. over the entire winter crop area of nearly 450,000 acres yielding 400,000 bales and ultimately to bring 600,000 acres in West Coast district under Sea Island cotton yielding 100,000 bales ranging from $1\frac{1}{4}$ in. to $1\frac{3}{4}$ in. staple cotton. The scheme is for five years and has the approval of the Indian Central Cotton Committee.

371. New Varieties of Cotton developed by Soviet Scientists. (*Soviet News*, **2025**, 1948, p. 4. From *Pla. Bre. Abs.*, xix, 1, 1949, p. 121.) It is reported that cotton immune from *Bacterium malvacearum* has been developed by crossing American varieties with those of India and Central Asia. Frost-resistant cottons have been distributed for cultivation in the Ukraine, Northern Caucasus and Stavropol region. Varieties have been developed in the Tajik Republic which are claimed to be superior in yield and quality to the Egyptian varieties previously cultivated; on some farms yields of 4,500 to 5,400 lb. per acre have been obtained.

372. Studies on the Perennial Cotton in Yunnan. (Min. of Agric. and For., Nanking. Special Publication 32, 1948.) I.—Observations on the Growth Periods and the Agronomic Characters. Hsi, Yuan-ling and Chen, Jen. The authors first describe the main characteristics of the two types of perennial cottons in Yunnan—namely, the economically unimportant kidney cotton—and the high-yielding free-seeded cotton which is similar to the Egyptian cotton (*G. peruvianum* Cav.). The latter has two growth periods a year, the first being from February to mid-August in which boll opening starts in early May and ends in mid-August. In the second growth period boll opening commences towards the end of October and continues until the following March. The productivity of the first period is, however, significantly affected by the mean temperature of the previous winter, and if this falls below 15°C. the first growth period of the following season is obscured. The fruiting habits characteristic of each growth period are described.

II.—Observations on Fruiting. Hsi, Yuan-ling. The mean of days required for boll maturation are 54 days and 91 days for the first and second growth period respectively. The variations of the boll maturing period during the first growth period tend to decrease from the beginning; at the beginning of the blooming stage of the second period, the tendency is in the reverse until the middle of the period. It is thought that these facts may be due to the variations of temperature and water supply within the growth season. Serious loss of yield is caused by pink bollworm attack, and under normal weather conditions the damage is higher during the second growth period. Cotton aphids and leaf hopper also are sometimes prevalent, but they can be controlled efficiently by use of tobacco extract.

III.—Effect of Pruning. Hsi, Yuan-ling. Pruning of perennial cotton consists of cutting back the shoot to a height of 1 foot above the ground. If it is carried out in early spring after the second growth period, the plant will not flower in the following six months, but if pruning is done in the late summer after the first growth period, the plant will give a small yield in the following season. The second crop from the pruned plant is much higher than that from the control, but it has yet to be established whether the increase wholly compensates for the loss on the preceding crop.

373. A Cleistogamous Mutant in Cotton. By L. Neelakantan and R. Balasubrahmanyan. (*Ind. Cott. Grwg. Rev.*, iii, 1, 1949, p. 69.) The corolla of a plant in the second generation of an interspecific hybrid—viz., *G. hirsutum* (Co. 2) × *G. barbadense* (Marad)—remained intact without unfurling till late in the evening although signs of rose-red tint indicative of fading were visible on the petals. The first observation made on June 14, 1948, was followed up by regular examination of the flowers produced on the plant for a further period of three weeks wherein sixty flowers were

studied. No flower bud unfurled its corolla during the period and all of them remained cleistogamous. Instances of cleistogamy provoked by either senility or adverse environment have been previously recorded but not a heritable type. A closer examination of the flowers excluded teratology as a possible causal factor. All floral parts other than the corolla were perfectly normal. Pollen was abundant and non-contabescent. Fertilization and boll formation were normal. The main difference lay in the shape of the petals. The usually flat truncate petal was changed into a winged shape having two lobes and a corrugation below the sinus. In *æstivation*, the corrugation of the sinus helped the petals to interlock so effectively that opening of the corolla was not ordinarily possible. There was no other distortion in shape or size of bud in both fresh and faded flowers. The genetics of the new mutant are being worked out.

374. Cottonseed: Treatment Tests. By S. C. McMichael and L. A. Brinkerhoff. (*Plant Disease Rept.*, **32**, 1948, p. 466. From *Summ. Curr. Lit.*, xxix, 7/8, 1949, p. 111.) Results are reported of four tests conducted over a period of years at a field station in Carolina to compare (i) different disinfectant dusts, (ii) recently treated seed with seed that had been treated and stored one year, and (iii) reginned, acid delinted, and fuzzy seed. Significant differences between seedling emergence of chemically dusted and undusted seed were obtained in two of the tests under conditions which favoured relatively poor germination for the untreated seed; when conditions were apparently favourable for germination, the dusts were of no benefit. Treated stored seed gave equal or better germination in two years, but yielded significantly fewer seedlings in a third year. Differences between the stored and unstored seed may have been due to age or origin of the seed. Acid delinted seed produced a higher percentage of seedlings in two of the tests.

375. Cottonseed: Viability and Growth; Effect of Chemical Treatment Prior to Storage. By M. G. Lambou *et al.* (*Science*, **108**, 1948, p. 563. From *Summ. Curr. Lit.*, xxix, **3**, 1949, p. 21.) Results are reported of an investigation on the effect of a mixture of propylene glycol dipropionate and 4 : 6-bis-chloromethylxylene on the viability and seedling growth of a Stoneville 2B variety of cottonseed. The treatment with the mixed chemicals successfully maintained viability and growth at a level considerably higher than that of an untreated control under identical conditions of storage. Analyses confirmed previous findings that the chemical treatment very significantly reduces free fatty acid formation during storage.

FIBRES, YARNS, SPINNING, WEAVING, ETC.

376. Cotton Fibres: Length Measurement. By R. Riso. (*Boll. Cotoniera*, **37**, 1942, p. 287. From *J. Text. Inst.*, **40**, 3, 1949, p. A108.) The fibre length is determined by an adaptation of Kuhn's method, in which a tuft of the raw cotton is weighed (W), combed out so that all the fibres are approximately parallel and straight. and then trimmed off at the top and bottom so as to give a central rectangular portion (weight w). Then the mean fibre length is given by: length of the side of the rectangle in the direction of the fibres $\times W/w$. Alternatively, Muller's method may be used to obtain the mean fibre length from the mean length/weight ratio of the fibres and the weight and dimensions of a composite right-angled triangle built up from a smaller such triangle and a trapezoid formed by making one horizontal and two diagonal cuts across the tuft of parallel fibres. Results are given.

377. Cotton Fibre: Strength Testing by Modified Flat-Bundle Method. By J. K. Phillips. (*Text. Res. J.*, **18**, 1948, p. 684. From *Summ. Curr. Lit.*, xxix, **5**, 1949, p. 82.) A new testing technique is described which permits the use of the Pressley fibre jaws on the Scott I.P-4 tester to measure the tensile strength of cotton fibre. This method also makes it possible to test the flat bundle at different test-specimen lengths of jaw spacings. Some data on cotton fibre and other textile fibres are included which show indications that the apparent tensile strength of cotton fibre decreases very rapidly as the jaw separation is increased.

378. RAW COTTON WAX CONTENT: DETERMINATION. By C. Lesslie *et al.* (*Annal. Chem.*, **21**, 1949, p. 190. From *Summ. Curr. Lit.*, xxix, **6**, 1949, p. 99.) Wax values obtained by the Conrad method on different samples of raw cotton subjected to different preliminary treatments are presented and the data show that the substance or substances responsible for increased wax values following treatment with hydrochloric acid are water-soluble. Cotton should not be treated with hydrochloric acid prior to wax analysis.

[*Cf.* Abstract 533, Vol. XXII of this Review.]

379. STAPLE DIAGRAMS: USE IN COTTON MILL OPERATION. By S. Carter. (*Text. World*, **98**, 12, 1948, p. 109. From *J. Text. Inst.*, **40**, 3, 1949, p. A111.) The effect of length and fineness of cotton fibres on yarn strength is discussed and an account is given of the use of staple diagrams in mills for determinations and control of staple lengths of raw materials, for ascertaining proper settings during processing and preventing loss of good fibres, and for nep and trash counts.

380. SPEEDING COTTON STAPLING. By J. Witherspoon. (*Text. Indus.*, **113**, January, 1949, p. 87. From *Text. Tech. Dig.*, **6**, 3, 1949, p. 238.) The latest model of the Fibrograph is described. The sample is combed to lay the fibres parallel and the combed fibres are placed between a light source and 2 vacuum phototubes, which replace the photovoltaic cell of the original design. This light is balanced against the light received by a third phototube from an incandescent lamp. A length distribution curve is drawn on a card. Operation of the instrument is discussed and illustrated with photographs and a diagrammatic sketch. The technique of Fibrograph calibration is also described.

381. RELATIONS OF COTTON FIBRES TO MILL MACHINERY. By B. Johnson. (*Cott. Trade J.*, **28**, 1948-49, p. 146. From *Text. Tech. Digest*, **6**, 4, 1949, p. 257.) The efforts of fibre technicians to learn more about cotton fibres and their behaviour in processing are discussed. The many variables to be considered in these studies are noted. It is concluded that laboratory cotton fibre tests, as now conducted, offer insufficient basis for predicting what will happen to the fibre in the mill; the fibre technician must devise means of measuring the relations of the fibres to each other and to trash in the sample if he is to predict successfully how the fibre will process. Fibre properties that are demonstratively related to yarn qualities are not necessarily positively associated with that phenomenon often referred to as a "smooth running mill."

382. METHOD AND MACHINE FOR COMBING COTTON AND OTHER TEXTILE FIBRES. By F. Raubitschek. (U.S. Pamph. 2,458,732, January, 1949. From *Text. Tech. Digest*, **6**, 4, 1949, p. 277.) This invention provides a method of, and machine for, combing cotton and other textile fibres, in which tuft-holding means are moved continuously around stationary combing means. The tuft-holding means comprises pairs of rollers, at spaced intervals, which hold the tufts as they are combed. In the progress of these rollers around the combing means, both ends of the tufts are presented to the combing means. This is accomplished by reversing the direction of rotation of the tuft-holding rollers. A number of advantages are listed.

383. NEW COTTON CARDING SYSTEM. (*Text. Rec.*, **66**, 1949, p. 55. From *Text. Tech. Digest*, **6**, 5, 1949, p. 358.) The operation of the "Nuclotex" system of carding is described. The new system, which is extremely simple, operates as follows: A secondary licker-in is situated immediately below the orthodox licker-in and has its own mote-knife and under casing. The lap from the picker is fed to the primary licker-in in the usual manner, the licker-in striking in a downward direction at the fringe of the lap fed through the dish plate. A considerable proportion of the larger and heavier impurities are stripped from the licker-in by the two mote-knives. A portion of the cotton adhering to the primary licker-in is brought into contact with the smaller diameter secondary licker-in, also travelling in a downward direction, rotating at a higher speed. The action of the secondary licker-in is to remove still more of the impurities from the cotton. The impurities escaping the action of the first licker-in will in most instances be extracted by either the secondary licker-in or by the card cylinder. The inventor claims that there is a

definite combing action taking place between the lickers-in which is reflected in the quality of the carding.

384. COTTON YARN: STRENGTHENING TREATMENT. (U.S. Rubber Co. B.P. 608,292 of 15/3/46. From *Summ. Curr. Lit.*, xxix, **5**, 1949, p. 75.) Cotton yarn is strengthened by treating it successively with an aqueous solution capable of swelling cellulose (ammonia, amines, alkali hydroxides) and a hot solvent for cotton wax (amyl acetate, toluene, tetrachloro-ethylene, etc.). The yarn may be dried between treatments and maintained under tension. The process may be continuous, providing for a stay of about 10 minutes in each liquid, or the yarn may be immersed on packages in one liquid, wound into new packages and then immersed in the other liquid. Fifteen examples are given to illustrate various aspects of the process and the results of breaking load and extension tests. In the first, an 18s/4/3 tyre cord was passed under tension through amyl acetate at 90°C., followed by 0·28 per cent. ammonia solution at 75°C. and the breaking load increased by 46 per cent. and the " fatigue life " (cycles of flexing to rupture) by 365 per cent.

385. COTTON YARN: ATMOSPHERIC TENDERING. By E. Race. (*J. Soc. Dyers and Col.*, **65**, 1949, p. 56. From *Summ. Curr. Lit.*, xxix, **9**, 1949, p. 155.) Recent work on the factors responsible for tendering of cotton on exposure is reviewed and results of atmospheric exposure tests are reported. Samples of cotton yarn were exposed to the atmosphere under various conditions, and tested for fluidity, breaking load, copper number, and carboxyl content. The results on yarns exposed in summer (1947) indicate that under the action of ultra-violet radiation and atmospheric oxygen the cellulose is converted into an oxycellulose of the reducing type. Yarns exposed in winter in industrial areas underwent greater degradation due to the greatly increased acidity of atmospheric moisture in winter than in summer, which tends to produce hydrocellulose. The least amount of degradation occurs during spring and autumn when the action of sun is less than during summer and the action of atmospheric acidity is less than during winter. Evidence is presented supporting the view that degradation is due mainly to oxidation in summer and to acid hydrolysis in winter.

386. MICROBIOLOGICAL DETERIORATION OF ORGANIC MATERIALS: ITS PREVENTION AND METHODS OF TEST. By E. Abrams. (U.S. Nat. Bur. of Standards Misc. Pub. 188, 1948.) For the purpose of evaluating cotton fabrics treated with mildew-resistant compounds, eight test methods have been studied. No single test offers a complete picture of the performance of a particular treatment under all service conditions. The tests that stand out as most useful are *Chætomium*-mycelial mat test; accelerated weathering test, followed by a subsequent *Chætomium* test; and the soil-burial test. Where the particular conditions of service are known, it may be sufficient to select a single test. But where a mildew-resistant treatment is required to protect under a wide variety of conditions, all three of the above tests should be used.

In evaluating these test methods, 35 of the most commonly used fungicides were used. The superiority of the copper compounds, especially copper naphthenate, has been demonstrated. Although not as effective, zinc naphthenate and zinc dimethyldithiocarbamate have been shown to be acceptable substitutes where copper compounds cannot be used. The chlorinated phenols have been shown to be excessively soluble and rather photochemically unstable. However, in the absence of light, pentachlorophenol and dihydroxy-dichlorodiphenylmethane would be excellent fabric fungicides. The pyridyl mercuric compounds appear to be the best of the mercury fungicides, although the acetate is probably too soluble for general use. Finally, it is obvious that no single compound may be considered the universal fungicide. Even copper naphthenate, which withstands extremely rigorous exposure, is not the ideal treatment. However, with a knowledge of the end use of the treated fabric, it is possible to select an effective fungicide from these 35 compounds.

387. PROCESS FOR MAKING COTTON TEXTILES WATER-ABSORBENT AND ROT-RESISTANT. By J. D. Reid and G. C. Daul. (U.S.P. 2,448,153, 1948. From *Text.*

Tech. Digest, 6, 5, 1949, p. 397.) According to this invention, a cotton textile is soaked with monochloracetic acid and then treated with a solution of an alkali metal hydroxide, such as sodium hydroxide, varying in concentration between 20 to 50 per cent., to give a resulting textile containing 1 carboxymethyl substituent per 40 to 50 glucose units, the higher carboxymethyl substitution going with the higher concentration of NaOH, which is swellable when wetted, and is water absorbent, the degree of swellability and absorbency being controlled by the strength of the hydroxide used and consequent degree of carboxymethyl substitution. The textile can be rendered rot-resistant by treating it further with solutions of certain metallic salts in such a matter that insoluble metal salts of the carboxymethyl groups present in the textile are formed. A salt which yields copper ions in solution thus to produce the copper salts of the carboxymethyl groups is quite satisfactory. However, other metallic salts, such as those which yield iron, silver, nickel, mercury, lead or alu-aluminium ions, may be employed. Treatment with a metallic salt also affects the manner of swellability.

TRADE, PRICES, NEW USES, ETC.

388. World Cotton Production. (*Cotton*, M/c., 21/5/49.) According to the United States Office of Foreign Agricultural Relations, world cotton production in 1948-49, now estimated at about 29,140,000 bales of 500 lb. gross, is 3,920,000 bales above a revised estimate of 25,220,000 for 1947-48. The 1948-49 crop is the largest since 1940-41 and nearly equal to the five-year pre-war average, with the exception of the record crop of the 1937-38 season. Most of the increased production in 1948-49 occurred in the United States. World production this year exceeds world consumption for the first time since the war.

389. International Cotton Advisory Committee. (*Cotton*, M/c., 30/4/49.) The Committee met in Brussels on Monday, April 25, 1949, for preliminary discussions on an international agreement to stabilize world cotton markets. The proposed agreement would be similar to the recently concluded world wheat pact, fixing world export quotas and maximum and minimum price controls, although it was understood that no agreement would be drafted at the present meeting. An annual review of the world cotton situation, presented to the committee, says the 1948-49 season would provide enough cotton for world demands, with about 500,000 bales to carry over into the next season. World production for season 1948-49 is estimated at 15 per cent. more than in 1947-48, and consumption about 2 per cent. less.

390. Skinner's Cotton Trade Directory of the World, 1948-49. (Pubd. by Thos. Skinner and Co. (Publishers) Ltd., London, Manchester, Bradford, New York and Montreal.) The twenty-fifth edition of this Directory, while following closely on the lines of previous editions, contains much additional information about firms in countries overseas. The statistical tables relating to raw cotton have been revised and extended, and a new section dealing with the linen industry in Great Britain has been introduced. The price of the Directory has been increased to £2 net, post free.

ERRATUM

Insect Pests of Cotton in Tropical Africa.—Additional Note by Dr. R. C. Rainey. Vol. xxvi, No. 2, p. 99, line 18: for "chemical" read "classical."

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METHODS AND RESULTS OF SELECTION EXPERIMENTS WITH PERUVIAN TANGUIS COTTON

PART II

THE "MASS PEDIGREE SYSTEM" IN PRACTICE

BY

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INTRODUCTION

THE first part of this article dealt with the bases underlying the methods of selection which have been used for the amelioration of Peruvian Tanguis cotton during the past nine years. It is now necessary to discuss the experimental details. The essential steps in the methodology may be summarized:

1. To examine a large number of single plant samples from the heterogeneous commercial crop, in order to obtain quantitative estimates of the main characters which are to be worked on, and to establish specifications or norms of the characters required.
2. To grow in progeny rows a large number of single plant samples which have passed preliminary tests (one replication).
3. To examine bulk samples from these progeny rows and to eliminate lines which fail to conform to the norms set up. This may be called the bulk norm test.
4. To examine all the single plants of the lines passing this test and to eliminate plants which themselves fail to conform to the norms. This may be called the single plant norm test.
5. From this material to select an élite of, say, 200 plants. To grow these in progeny rows with an adequate number of replications.
6. To apply the bulk norm test to eliminate undesirable lines, and also to eliminate lines which in yield of seed cotton per plant are below the mean of the whole population of lines.

7. To mix the seed of lines which pass the norm test and to institute a multiplication plot on the Experiment Station.

8. To plant the whole production of No. 7 in an isolated field or a large farm.

9. To plant the whole production of No. 8 on a large area of the same farm.

10. To distribute the production of No. 9, as the first commercial wave of seed—approximately 1,000,000 lb.

11. To continue the steps from 2 to 10, with such modifications as practical exigencies necessitate, so that each year a new wave of seed of approximately 1,000,000 lb. of seed can be distributed.

The Experiments

In the following description of the experiments a good deal has had to be omitted. A full account is given elsewhere (Harland, 1944).

Preliminary Examination of Material

This was done between January and August, 1940. As the number of seeds per loculus is about 8 to 10, single loculus samples selected at random from the large quantities of seed cotton available at commercial ginneries formed convenient units for examination and preliminary selection of planting material. About 22,000 single loculus samples were thus examined. It was established that the main characteristics of the current Tanguis variety were as follows:

Lint length—$1\frac{3}{16}''$ Washington standard.
Ginning percentage—37·0.
Colour—in general white, but much mixed with various shades of brown and cream.

After elimination of all samples which were of bad colour, or the lint of which was too short, there remained for planting 6,528 loculi, of not less than nine seeds per loculus. Of these 2,863 rows were planted at the beginning of October, 1940. As a result of using the Egyptian system of sand sowing, an almost perfect stand was obtained.

The Results of 1940-41

Material planted at the beginning of October should give a good first picking at the end of May, followed by two further pickings in June and July. The growing season is thus ten months or longer. This is due to the lower temperatures of the Peruvian coastal area, an effect of the cold Humboldt current. Although the Tanguis variety is a sympodial type, the node number in fact being rather lower than that of Egyptian (about 11), the first flower does not appear until about ninety days after sowing. The main results of 1940-41 are set out in Table I.

TABLE I

THE SUMMARIZED RESULTS OF 1940-41
BULK MEAN TEST

Character	Old Mean	New Norm	Number of Strains: Passed	Number of Strains: Failed
Lint length*	19	20	1255	1603
Preliminary Colour	—	—	1190	65
Boll weight	4·4	4·5	562	628
Colour and Fineness	—	—	209	353
Ginning percentage	37·1	39·5	—	—
Yield seed cotton per plant	—	—	41	168

* Units of $\frac{1}{16}''$.

The last two tests were combined so that only the rows above the general arithmetic mean of the whole population of lines for yield were examined for ginning percentage.

Final Single Plant Selections

When the 2863 strains had been subjected to examinations for five main characters, there remained only 41 strains, or slightly below 1·5 per cent. of the original number of strains. There would naturally be considerable variation from plant to plant in the 41 strains, since only the bulk means complied with the specifications established. Some of the plants would be inferior segregates; others would be of hybrid constitution through natural crossing, in most cases with inferior types. It was therefore not to be expected that the first wave of commercial seed would continue for a long time to comply exactly with the norms. Segregation in inferior types would continue to occur for some time.

If every plant of the 41 selected lines had been grown on there would have been 400 progenies to deal with, even with one replication. It therefore seemed advisable to eliminate all single plants which did not conform to the norms, and to select 200 élite plants for progeny testing in 1941-42.

Experiments of 1941-42

Two thousand rows were grown from 200 élite plants, with ten replications of each progeny. The results may be summarized as follows:

TABLE II

THE SUMMARIZED RESULTS OF 1941-42
BULK MEAN TEST

Character	Old Mean	New Norm	General Mean	Number of strains: Passed	Number of strains: Failed
Lint length*	19	20	22	182	18
Boll weight	4·4	4·5	5·0	189	11
Ginning percentage	37·1	39·5	39·8	109	81
Colour	Inferior strains eliminated.				
Fineness	"	"	"		
Yield	Strains below general arithmetic mean eliminated.				

* Units of $\frac{1}{16}''$.

The test for colour and general Tanguis character was made more stringent. Thus out of the 200 strains 43 were available for general multiplication, and for ultimate distribution under the name SNA 242.

Reference to the above table will show the great improvement which has been effected by the only two generations of mass pedigree selection. Since the bulk means conform to certain norms of behaviour a mixture of strains which have passed the tests will give a bulk population which will have the characters of the constituent populations weighted for the amount of seed contributed by each. No single strain will be pure for even any one character, but in absence of strong adverse natural selection affecting the multiplication rate of desirable gene combinations, the bulk population may be expected to conserve the new norms for some time, as well as to provide starting points for further improvement.

Experiments of 1942-43

The general objective was to continue selection on much the same lines as in the two previous years. The main points in procedure were as follows:

1. The ten best strains were selected: ten separate plants from each. The strains trace back to only seven of the original 2863 strains grown the first year.

2. Individual plants were not subjected to the norm test. This resulted in the selection of a number of poor parents which could have been eliminated, and in much unnecessary work.

3. In addition to the replications, four observation rows, planted at the commercial spacing of 1 m. 20 cm. × 40 cm. were grown of each of the 100 lines. These rows served for the general examination of the vegetative characters, habit, precocity, wilt resistance, etc., and also provided material for the examination of the morphological characters important in selection—*i.e.*, lint length, boll weight, ginning percentage, colour, and fineness.

The results may be summarized as follows:

TABLE III

THE SUMMARIZED RESULTS OF 1942-43
BULK MEAN TEST

Character	*Old Mean*	*New Norm*	*General Mean*	*Number of Strains*	
				Passed	*Failed*
Lint length*	19	22	22+	82	18
Boll weight	4·4	4·5	4·7	63	37
Ginning percentage	37·0	39·5	40·5	91	9
Colour, Fineness, Yield ..			As before.		

Number of strains eliminated 37.
Bulked for commercial multiplication 63 strains as SNE 243.

* Units of $\frac{1}{16}''$.

Later Experiments

The procedure followed in subsequent years differed little from that just described. After elimination of inferior lines for three years had been accomplished it became clear that the characters which had been aimed at were commercially stabilized, so that while it was necessary to produce a new wave of seed every year, to counteract the effects of mechanical mixing at ginneries with bad seed, and possibly adverse effects of natural selection running against some of the norms, it was now possible to concentrate on other objectives. It may be mentioned that during the last three years the standard for lint length has been lowered to the first objective of $1\frac{1}{4}$ in. from the value of $1\frac{3}{8}$ in. which characterized SNA 242 and SNA 243. It was realized that the consumer was not prepared to pay more for a superior cotton. By lowering the standard for lint length it has been possible to raise the norm for lint percentage, so that later commercial multiplications have the extraordinarily high percentage of 42·5. It must be emphasized, however, that the length can be raised or lowered at will, as indeed can any of the other characters of importance. A few general remarks may now be made about the varieties released to the farmers. The first wave, SNA 242, has now been grown for six years by farmers, SNA 243 for five years, etc. All the characters have well maintained their new norms, and quality and colour are regarded by the consumer as especially satisfactory. All the late maturing tree types have been eliminated and the crop is uniformly earlier maturing. In regard to the yielding power of the new strains it is not possible to get an exact idea of the increased yield without carefully replicated comparisons. It is significant, however, that the weight of seed cotton per plant is now about 10 per cent. greater than that of the combined lines of 1941-42 and 52 per cent. greater than that of the combined lines of 1940-41.

The farmers themselves are of the opinion that the new types are much heavier yielders than the old, and on more than one occasion yields of over 1,000 lbs. of lint per acre have been obtained on 50-acre blocks.

The view now held is that progress in yielding capacity has about reached its limit. The potential yield is far greater than that ever actually obtained. Much of the cotton in the country is grown year after year on the same land without adequate manuring. The soil has lost its crumb structure. In spite of the application of heavy doses of the latest and most powerful insecticides, the destruction caused by insects in 1948-49 has been very great, and many farms have been run at a loss. It is not too much to say that unless the ravages of Heliothis boll worm and aphis can be mitigated, the genetical progress in yielding power which has been made will be rendered nugatory.

It will be remembered that among the objectives specified as im-

portant at the beginning of the work was the maintenance of genetical heterogeneity. The ninth objective was as follows:

"To maintain such a degree of heterogeneity in the crop as to permit selection at any time for characteristics which become necessary."

There are several important additional objectives which may probably be attained without detriment to the characters already stabilized.

Besides the obvious objectives of resistance to disease and insect pests, it is likely that great changes in the basic chemistry of the cotton plant can be brought about by selection—*e.g.*, increased oil content of the seed, and ultimately control of the nutritive value of seed proteins. As part of a long-term programme of streamlining chemical characteristics, a successful attempt has been made to increase the oil content of the seeds. High resistance to Verticillium wilt has also been attained.

Resistance to Verticillium Wilt

In some regions of Peru the Verticillium wilt disease is widespread and destructive. Indeed one of the reasons for the abandonment of the former cotton industry based on the Upland variety Suave was its extreme liability to wilt. The original selection of Tanguis was said by its originator, Señor Fermin Tanguis, to be highly resistant to wilt, and this was certainly one of the reasons why Tanguis so rapidly replaced its predecessor.

But with the lapse of time Tanguis has lost a good deal of its former resistance and there are now certain regions in which cotton growing can no longer be carried on owing to wilt. In considering an attack by a parasitic organism it must be borne in mind that four factors are interacting to produce the final result.

1. The hereditary constitution of the organism.
2. The ecology or environment of the organism.
3. The hereditary constitution of the plant.
4. The ecology or environment of the plant.

Taking up these points one by one, we do not know whether in recent years the Verticillium organism has changed its genotype—*i.e.*, whether it has mutated to produce more virulent races which can attack Tanguis. No observations have yet been made on biological races of Verticillium in Peru, though by analogy with other fungi we should certainly expect them to exist. In this case selection for resistance in one locality only would produce a resistant variety for that locality. The same variety might be strongly attacked in another part of the country. A survey of the organism from the point of view of biological races is therefore necessary, though we might begin with the assumption that such races do exist and carry on selection work in plots artificially infected with material obtained from all parts of the country.

Regarding the ecological aspect, it is known that certain temperature conditions favour the fungus and others the plant. These factors have also been insufficiently studied.

Respecting the genetical constitution of the plant, it is probable that natural or artificial selection of certain genotypes may have run counter to resistance. One case was noted of a farmer who wanted an earlier maturing cotton. He selected seed from the earliest maturing plants. Many of these had certainly been attacked by wilt which had caused them to open their bolls prematurely. The descendants of such plants would probably be much more susceptible than the general run of the crop.

It will therefore be seen that the general problem of selection for wilt resistance is by no means simple when the above four aspects are taken into consideration.

Methodology

For the first three years of experiment wilt was not of great importance. It was then found that attack by wilt became serious in some plots which had been continuously under cotton for seven or more years, and this provided the opportunity to select for resistance under the conditions of the Experiment Station. The methodology used is based on the improbable assumption that the existence of biological races of Verticillium need not be taken into account. The experiments, although reasonably successful as a demonstration of method, require to be extended to other cotton-growing areas, and the resistant varieties to be tested over a large range of conditions.

The first point of importance in considering method is that Tanguis is grown for three successive years. If the crop has a large number of productive plants alive for three seasons it is not important that they should be completely immune. Unless immunity is complete they may all die ultimately of wilt. But if a heterogeneous series of lines is planted in a plot known to carry heavy infection, we can first get an estimation of the rate at which plants are succumbing to infection in the different lines and then find out whether the progeny of plants in lines which have survived for several years with the least loss are more resistant than the commercial crop generally.

The Experiments

Experiments were started in 1943-44 by leaving two of the repetitions for a second year of study. The plants were cut back after the first crop in the usual way and the number of deaths from wilt noted from time to time. It was soon obvious that great differences existed between the lines for susceptibility to wilt. A great many lines died out altogether

during the year, and still more during the third year. From three parent plants which remained healthy for four years in a strongly infected plot, three lines resistant to wilt have been isolated. One of these, No. 799, which is being propagated commercially was also the heaviest yielding type in the trials of 1946-47. It was noteworthy that as the most important characters had already been stabilized by three years of mass pedigree selection, the three resistant lines conformed to the established norms.

It is interesting to note that this method of securing disease resistance by using material from lines which succumb to disease most slowly and are the slowest to be attacked was used by the writer to obtain lines resistant to Black Arm in the West Indies in 1916-18 and in Brazil in 1935-38, where a highly resistant line of Stoneville Upland was easily isolated.

To sum up: after stabilization of lint length, ginning percentage, boll weight, colour and yield, sufficient genetical variability remained in the population of lines to select successfully for resistance to wilt.

High Oil Content

Cotton is both a fibre and a food crop. It is more likely that in the near future good agricultural lands will be needed for food production, and that their use for fibre alone will not be justified. But if the oil content of the seed can be elevated by genetical means without affecting the commercial characteristics of the crop, it will be possible to justify cotton purely as an oil crop.

Suggestions have been put forward in the United States to grow a lintless variety of cotton as an oil crop, but if such a variety were available, surely the first thing to do would be to put as much fibre on the seed as possible so as to extend the range of usefulness of the variety. Selection effects on characters hitherto not subjected to selection are in themselves of great genetical interest. By how much can the oil content of cotton be increased without affecting the quality and quantity of the fibre?

It has been known for some time that different varieties of cotton differ considerably in oil content. Brown and Anders (1920) give data of twenty-five varieties cultivated in the state of Mississippi. It was shown that the oil percentage varied from 17·01 to 21·67.

Harrinton (1928) made a comparative study of seventy-three varieties in Texas and got a range of 10·64 to 18·50 per cent. It is known also that there is a considerable environmental effect on oil content.

It appears that the oil content of varieties of *Gossypium barbadense* (Sea Island, Egyptian, Tanguis, etc.) is considerably higher than that of Upland, partly due no doubt to the fact that Uplands have fuzzy seeds, which reduces the proportion of embryo to husk.

An investigation has been made of the oil content of a number of lines of Tanguis, already stabilized for the specifications previously outlined. As was found to be the case for wilt resistance, there remained sufficient genetical variability in the population of lines to enable the extraction of high oil lines to be made. Commercial Tanguis has an oil content of about 21·8 per cent. Industrial extraction is somewhat inefficient, the extraction in one of the Lima mills being 16·26 per cent. (mean of 14 years).

The following table gives preliminary results for some of the best lines:

Line	*Per cent. Oil*
Tanguis general	21·8
46-160	29·23
45-36-3	26·99
45-367	26·85
45-323	26·68
45-332	26·45
45-44-11	25·87

From these results it appears that there are vast possibilities for selection for high oil content of cotton seed. The above high lines are normal for both quality and quantity factors. If the oil content of Eygptian and Indian varieties could be increased to the value of 29 per cent., a great contribution to the world shortage of edible oil could result.

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THE DISSEMINATION OF COTTON IN AFRICA

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1. Introduction

The genus *Gossypium* includes lintless and linted species, and these form two distinct groups. The lintless species, which are wild desert shrubs, bear seeds covered with short, non-expansive brown hairs. Three of them are indigenous in Africa. The linted species have seeds bearing a copious coat of long, fluffy, convoluted hairs (Hutchinson, Stephens and Dodds, 1945). It is these convoluted hairs which form the cotton lint of commerce, and the species which produce them are in general cultivated, or in some cases secondarily wild. They are the true cottons, and in this paper the term " cottons " will be used to denote the linted, as distinct from the lintless, species of *Gossypium*. The centres of origin of all the cottons lie outside Africa, and it has been concluded that they are not native there, but have been introduced by man on account of the raw material they provide for spinning and weaving (Hutchinson, Silow and Stephens, 1947). In Africa they are, with one exception, still confined to his farms and gardens, and even this exception (*G. herbaceum* var. *africanum*) occurs in an area where spinning and weaving were formerly practised (Kenyon, 1931), and was probably at one time a cultivated plant (Quintanilha *et al.*, 1948).

Four species contribute to the world's cotton crops—*G. arboreum* and *G. herbaceum*, which are diploid and of Asiatic origin, and *G. barbadense* and *G. hirsutum*, which are tetraploid and are indigenous in the New World. Though not native in Africa, they have all been long established there. The Asiatic species were in use before European exploration of the continent, and those of America were among the early introductions of crop plants from the New World. Deductions concerning their arrival and spread chiefly depend, therefore, on the data of present-day distribution and taxonomic relationship, and agricultural and historical records are of little value except in respect of the most recent introductions.

2. The Distribution of the Species

The Asiatic Species

Gossypium arboreum is represented in Africa by two races. The more important is race *soudanense*, which occupies the Sudan-West

African region. *Soudanense* cottons are to be found as odd plants or small groups in house-yards, fields and abandoned cultivations. They grow into strong shrubs or small trees, often with trunks 3 in. in diameter. In the Sudan they are still used in outlying parts to provide lint for spinning. In West Africa they are more often used for medicinal purposes and as a fetish (for such purposes the red-leafed form seems to be preferred), but are still sometimes spun. Specimens have been collected from Egypt to the Nile-Congo divide, and from the borders of the Sahara in French territory to Lagos in Nigeria and Tamale in the Gold Coast. In Somaliland they have been collected from the Juba and the Webi Schebeli. Though they have been recorded wherever the peoples of the region spin and weave, they are commoner in orchard bush and acacia savannah country than in forest regions, and are much commoner in the Anglo-Egyptian Sudan than in West Africa. It has been stated elsewhere (Hutchinson, 1947) that *soudanense* occurs in Angola, but careful examination of the Kew and British Museum material revealed nothing south of the Congo on the western side of the continent that could be ascribed with any confidence to *G. arboreum*.

The East African form of *G. arboreum* is sufficiently closely related to the Indian cottons to be allocated to race *indicum*. It is to be found in Madagascar, where it was formerly cultivated extensively, and on the Tanganyika coast. Sir John Kirk stated that in 1860 "*Tonje kaja*, or native cotton, is cultivated by the people on the Zambesi and up the Shire to Lake Nyasa." (Quoted by Watt, 1926.) Kirk's specimens include one of *G. herbaceum* resembling var. *acerifolium* (see below) as well as several of *G. arboreum*, but that *Tonje kaja* was *G. arboreum* is indicated by his statement that the "involucre is not much divided into segments."

Annual forms of *G. arboreum* have been introduced into the French Sudan and the northern Ivory Coast, and are now grown there commercially ("Budi" cotton). They are of only local interest.

Three forms of *G. herbaceum* occur in Africa. The annual typical form was formerly cultivated in northern Egypt and along the shores of the Mediterranean. It is not found south of the Sahara, and will only receive brief mention in what follows.

The perennial var. *acerifolium* is widely distributed in the Sudan-West African region. Types examined in the field and in culture form a reasonably homogeneous collection of perennial shrubs, rather smaller and bushier than the *soudanense* types from the same areas, but equally long lived. Chevalier (1936) has stated that this was the plant which provided lint for the native cotton goods of West Africa before the introduction of the New World species. *Acerifolium* is found in much the same territory as *soudanense*. It has been collected in Abyssinia and the Sudan, but is uncommon. In the Kew herbarium there are

specimens from the Kharga and Siwa oases in Egypt, and from Giarabub in Libya. Three collections recently received from the region of Jidda (western Arabia) proved to be of this race. In West Africa, on the other hand, *acerifolium* is much commoner than *soudanense*, and is to be found in localities ranging from Air and Reggan to Oubangui-Chari, Dahomey, and Senegal, and as far south as Ilorin and Abeokuta in Nigeria.

The wild var. *africanum* is commonest in the bushveld of Swaziland, the north-eastern Transvaal and Southern Rhodesia, and neighbouring regions of Portuguese East Africa. Herbarium material exists from as far north as the Zambesi, but Quintanilha *et al.* (1948) have shown that its present northern limit in Portuguese territory is the Save River. It has been collected from scattered localities in Southern Rhodesia (Bulawayo), Ngamiland, Bechuanaland, and Omboland. Two specimens of Asiatic cotton have been collected in Angola. One is S. Simpson's "Wild cotton growing freely near Humbe, Mossamedes, Angola," in the Kew herbarium, and the other is Exell and Mendonca's 2835 in the British Museum from Huila Vila Pereira D'Eca. Neither specimen has flowering or fruiting material, so it is not possible to say with certainty to which Asiatic species they belong, but they would fit satisfactorily in *G. herbaceum* var. *africanum*.

The New World Species

In *G. hirsutum* the Uplands are the most important commercial cottons of the rain-fed areas of Africa. Almost without exception, they were derived from the United States Cotton Belt. The early introductions were, for the most part, of the better quality American varieties, such as Allen, Sunflower, Black Rattler and Floradora. No adequate precautions were taken to maintain the purity of the varieties in the early tests, and very shortly the combined effects of intra-varietal variability, inter-varietal mixing and hybridization, and local environmental selection obliterated all evidence of relationship to particular American progenitors. In the British colonies and in the Anglo-Egyptian Sudan, the resulting mixture has given rise to a number of highly variable locally adapted stocks which have yielded, under selection, the best commercial varieties now in cultivation. The more important of these local stocks are "Allen" in Nigeria, "Pump Scheme Strain" in the Sudan Buganda Local and the N17 derivative of Nyasaland Upland in Uganda, Lake Province Local in Tanganyika, and Nyasaland Upland in Nyasaland.

G. hirsutum var. *punctatum* is acclimatized and well established throughout the north African savannah tract from Senegal to the Red Sea, and is to be found occasionally on the Tanganyika coast, and in

Madagascar. The variety is indigenous in the lands bordering the Gulf of Mexico and from there it was no doubt introduced to the west coast of Africa. Chevalier (quoted by Wouters, 1948), referring to the Senegal *punctatum* type known in the vernacular as *Ndar-gau*, has stated that "*Ndar* is the local name of the isle of Saint-Louis in Senegal, which seems to indicate that the introduction into West Africa was made at this point" (trans. from French). Its distribution in West Africa supports this view. In Nigeria and the Gold Coast it is common in the northern dry savannah tracts, and is rare or absent in the southern forest regions. *Punctatum* is not recorded from the dry coastal Accra plain, to which it seems ecologically suited. In the Gambia, on the other hand, it is well established near the coast. Apparently, therefore, the first introduction was on the Gambia-Senegal coast, and it spread thence to the Sudan and as far as the Red Sea. It has recently been collected in western Arabia.

In West Africa *punctatum* has almost completely supplanted *G. herbaceum* in native cultivations. Chevalier (quoted by Wouters, 1948) has given information that dates the change fairly closely. He states that Adanson remarked on his specimen of *G. herbaceum* var. *acerifolium* from Senegal *c.* 1750 that it was "the better of the two cottons of Senegal." Since Adanson refers to two types only, it is probable that the second was *G. arboreum*, and that the *punctatum* cottons had not then reached West Africa. About 1825, however, Perrottet remarked that "the variety *acerifolium* is not cultivated in Senegal," but was removed from fields of *punctatum* as an undesirable weed.

At the present time, considerable fields of a long-lived perennial form of *punctatum* are to be seen in northern Nigeria in the areas north and west of the commercial Upland tract. They are situated for the most part on sloping land running down to black soil swamps, or "fadamas," where moisture conditions are rather better than on the general run of farming land, and as the country becomes drier northward, cotton is more and more strictly confined to the moister fields. In the Gold Coast annual cultivation is the general rule, and a local early form is used. The Gambia, French Soudan and Chad *punctatums* are also very early types suited to annual cropping.

In the Sudan, in house yards and gardens outside the commercial cotton-growing tracts, *punctatum* is about as common as *G. arboreum* race *soudanense*, but only perennials are found, and there is not the same wealth of forms as in West Africa. The *punctatums* of the Tanganyika coast, and those of Madagascar, may well be derived from a distinct introduction from the New World.

The "Hindi weed" cotton, which has, in the past, been a source of considerable trouble in Egyptian cotton crops, is a form of *punctatum*. It is not typical, being annual in habit, and having larger bolls, and

larger seeds, than are usual in *punctatum*. Its rather distinctive characteristics may be ascribed to selection for survival as an annual weed in the Egyptian crop.

The Caribbean tree cotton, *G. hirsutum* var. *marie-galante*, has not hitherto been recorded outside the New World. It cannot be separated with certainty from *G. hirsutum* var. *punctatum* in herbarium material, since the essential distinguishing features are its tree-like habit, as opposed to the bushy habit of *punctatum*, and the photoperiodic control of fruiting. The absence of records of *marie-galante* from the Old World may therefore be due to failure to recognize it. Nevertheless, sufficient living material has been studied to justify the conclusion that it does not occur in India, British territories in East Africa, the Sudan, or Nigeria. In the Gold Coast, on the other hand, it is common, and it has recently been received from the Ivory Coast under the name of *Koronini*. It was probably introduced into the Gold Coast by the Basle missionaries, who brought Christian negroes from the West Indian islands of Antigua and Jamaica in 1843 and settled them in Acrapong, about 40 miles north of Accra. The Mission took a great interest in the trial of new plants in West Africa, and advised the negro immigrants to bring their crop plants with them. The *marie-galante* cottons in the neighbourhood of Acrapong are very similar to those of Antigua and Jamaica (see Hutchinson, 1943, and Hutchinson and Stephens, 1944), and it is there that the variability is highest, so there is good evidence that this was the point of introduction.

G. hirsutum var. *marie-galante* is now widely distributed in the Gold Coast. Small field crops, and rather bushy thickets of half a dozen plants or so, are common on the relatively dry Accra plain. Large shrubs or small trees may be seen in house-yards or open spaces in villages in forest country. In the orchard bush and long grass savannah country of northern Ashanti and the southern part of the Northern Territories, small plots of *marie-galante* are to be found, up to an acre or so in extent. They are sometimes allowed to grow into a great thicket of overgrown shrubs or small trees, and sometimes cut back annually. The northern types are more uniform than the southern, and possess a degree of hairiness that must provide at least some protection against jassid attack. Their most striking feature, however, is their resistance to blackarm disease. Blackarm resistance has only once previously been recorded in *marie-galante*, and two types tested from the southern Gold Coast were susceptible, as are the *marie-galantes* of the West Indies and South America. Four types tested from northern Ashanti and the southern part of the Northern Territories, on the other hand, were highly resistant.

G. barbadense has been introduced almost all round the African coast. It is widely spread in the forest regions and orchard bush country of

West Africa, and has provided the stocks on which the extensive irrigated cotton crops of the Nile valley have been founded. Typical West African *barbadense* cottons are large shrubs, up to 8 ft. or 10 ft. tall, with large leaves and rather large, pitted bolls. Where they have light and space they usually develop a number of strong, ascending vegetative branches, but these are often suppressed by the heavy competition in the mixed crops in which they are grown. An early form, said to have come from French territory, is common in annual cultivations in the northern Gold Coast.

In many areas *G. barbadense* is no more than a house-yard cotton, or an occasional component of secondary vegetation. Its position in Angola was described by J. Gossweiler (*in litt.*) as follows: " 'Algodao indigena de Catete,' of which some people talk, is nothing better than the old Brazilian kidney cotton, persistent during half a dozen years and often found in thickets in the littoral region of Luanda." Its status is similar in the Belgian Congo, Northern Rhodesia, coastal Tanganyika and the southern Sudan, and it is to be found occasionally in British Somaliland and western Arabia. On the east coast both kidney and free seeded forms were spread inland by the Zanzibar Arabs. Its penetration into the Congo from Angola and the lower Congo valley on the west and from Tanganyika on the east has been described by Wouters (1948).

G. barbadense is of some importance in West Africa. In southern Nigeria it provides raw material for a considerable local hand spinning and weaving industry, and though, on the crop standards of cotton-exporting countries, yields are quite uneconomic and pest damage enormous, it has a permanent place in the agricultural economy. It is generally grown as an annual in mixed cropping with yams, maize, and beans. No other cotton would stand up to the smothering competition of the yam vines, yet these *barbadense* types survive and produce a modest crop after the vines have died down. They are not uprooted, but are left as supports for the following years' yams, or to perish in the regenerating bush. There are three main types. The important ones are those formerly known as *G. vitifolium* and *G. peruvianum*. Both are typical *G. barbadense* as the species is now understood. The third type is the kidney cotton, *G. barbadense* var. *brasiliense*. All three intercross freely where they meet, but the distinction between *vitifolium* and *peruvianum* has been maintained by a difference in their ecological preferences. *Vitifolium* is the cotton of the forest region, and *peruvianum* that of the orchard bush country. The improved Ishan A was selected from *vitifolium* in the forest region, and has been distributed by the Nigerian Department of Agriculture. It is ill suited to the orchard bush country, and in the absence of regular seed introduction is soon replaced by *peruvianum*. Ishan A has been fairly extensively grown

in the southern Ivory Coast, but its replacement by Upland is now being considered (*vide* E. O. Pearson, *in litt.*).

G. barbadense was encouraged in Togoland by the Germans, and is well established in the forest belt, though it is of no commercial importance. It was called Sea Island, but it shows no sign, in either plant habit or lint quality, of Sea Island ancestry. Kidney types are common, and from leaf and boll size and shape, and the amount of kidney to be seen, Togo *barbadense* may be described as a hybrid swarm of *vitifolium* × *brasiliense* ancestry. The crop is generally grown as a perennial, and though rarely grown pure, does not suffer from overwhelming competition in the first year and is usually kept clear in the second. Consequently a longer lived perennial type has been developed in Togoland than in Nigeria.

Barbadense spread from the forest region of southern Nigeria to French Equatorial Africa, where, according to Gautier (1946), cottons are to be found scattered along the old invasion and slave routes between the Nile and the Gulf of Guinea. The common one is evidently an Asiatic, but he says that " another rarer type only found on good alluvial lands, especially in Mayo Kebbi, gives a long lint (40-42 mm.) with a pointed, very waxy capsule, like that of Egyptian cotton, the seeds sometimes black with a little fuzz at the tip, sometimes covered with a green or white fuzz; the types are very numerous, all with a strong appearance of relationship with the Ishan of Nigeria " (trans. from the French). This is evidently a *barbadense* and has just the characters that must have been possessed by the progenitors of the Egyptian cottons.

The modern cotton industry of the Nile valley dates from Jumel's discovery of a perennial *G. barbadense* in Maho Bey's garden in 1820, and its establishment as a field crop (Dudgeon, 1917). Jumel's success led to the introduction of many other types for trial in Egypt. Nearly all failed, but Sea Island was grown on a small scale for a long time. Being a race of *G. barbadense* closely related to the Jumel cotton, extensive hybridization took place, and it was out of the resulting hybrid swarm that the modern annual, high quality Egyptian cottons were selected.

3. Discussion

The earliest African people known to have used cotton were the men of Meroe in what is now the northern Sudan, *c.* 500 B.C. to *c.* A.D. 500, and the common Asiatic cotton of the Sudan today, *G. arboreum* race *soudanense*, is no doubt the modern representative of their stock.*

* Bond (1925) has given an interesting account of the establishment and growth of perennial cotton near the River Nile in Dongola, northern Sudan. Holes were dug in the sand down to the level of the river alluvium, and were filled with silt dug from a nearby well. Seedlings were established in these holes by hand watering. In due course their roots penetrated to the level to which water seeps through the alluvium from the river. Thereafter, no further attention was required. The trees, mulched by blown desert sand, and kept free from weeds by the aridity of the surface, flourished for ten years or longer. It is not unlikely that this method of cultivation was used in Meroitic times.

Presumably the *soudanense* cottons spread across the savannah tract to West Africa from the original introduction that gave rise to the Meroitic industry.

The similarity of the *G. arboreum* cottons of Madagascar and the East African coast to those of Western India (race *indicum*) leaves little room for doubt that they were brought from India by the Indian Ocean trade routes, probably more recently than the introduction of the *soudanense* cottons to the Sudan. The industry in Zambesia and Nyasaland, described by Kirk, may be related to that of Madagascar, since they both used the same cottons. It was probably distinct from that south of the Zambesi, where the only Old World cotton known is *G. herbaceum* var. *africanum*.

G. herbaceum was introduced into northern Africa from the Levant and Arabia by the Moslems. The annual typical form came from Syria and Turkey, and was widely distributed round the Mediterranean (Watt, 1907). Dudgeon (1917), who has given the best account of the pre-Jumel cottons in Egypt, states that the annual form " certainly occurred in the delta in Egypt as a field crop after the middle of the sixteenth century, and perhaps very much earlier." The perennial var. *acerifolium* appears to have come from western Arabia, and its presence in the desert oases of Egypt and Libya indicates the probable route by which it spread to the savannah regions of West Africa. It was never a crop in Egypt or the Sudan, presumably because the Meroitic cotton *G. arboreum* race *soudanense* (the " Senaar tree cotton " of Egyptian literature) was well established. In West Africa the Moslem invaders built up their own empires, and the cotton they brought flourished with their flourishing textile crafts. So it came about that in the Moslem area of West Africa the *soudanense* cottons were replaced, and *acerifolium* provided the raw material for cotton spinning until it was supplanted by introductions from the New World. In the pagan areas beyond the limits of the Moslem invasion, on the other hand, *herbaceum* is rare and the earlier introduced *soudanense* remains the commoner Asiatic species.

In these days the populations of *G. arboreum* and *herbaceum* in the north African region are so small that they must rarely occur together, and no crosses between them have been observed. When they were the sole sources of cotton for the local spinners, and in particular when *acerifolium* was spreading through the *soudanense* area, frequent opportunities for crossing must have occurred. In this connection Stephens drew attention to the similarity between " crumpled " (Hutchinson, 1932) and the " corky " type found in F_1 hybrids between certain types of G. *barbadense* and *G. hirsutum* var. *marie-galante* (Stephens, 1946). At the time of his report the distributions of the Asiatic species in Africa were not sufficiently understood for the significance of " crumpled " as an isolating mechanism to be apparent. It can now

be seen that the complementary crumpled genes are so distributed as to complete the species barrier between *G. arboreum* and *G. herbaceum* in just those parts of their range where they have been longest in contact—namely, Western India (see Bhola Nath and Govande, 1943) and the Sudan and West Africa.

The South African *G. herbaceum* var. *africanum* is fully established in natural vegetation, and the only available record of the utilization of cotton in this area is the statement by De Barros (*c.* 1560), quoted by Kenyon (1931), that cotton goods were manufactured in the country of the Monomotapa. Quintanilha *et al.* (1948) have recently discussed the status of the variety in Portuguese East Africa. They found that its northern limit at the present day is the Save River, though there is ample herbarium material to prove that it formerly extended as far north as the Zambesi. They point out that the Save River marks the vegetational change from open forest and grasslands dominated by Paniceæ, to closed forest and savannahs dominated by Andropogoneæ. In the open forest and grasslands to the south there is ample open space between the small and scattered Paniceæ for the establishment of the light-loving cotton seedlings. In the northern closed forests, and grasslands with a dense cover of tall Andropogoneæ, they would be choked. Moreover, Quintanilha *et al.* report that the cottons still to be found south of the Save River " belong to *G. herbaceum*, but with characters intermediate between the varieties *acerifolium* and *africanum*—longer, more abundant, and whiter lint than in *africanum* " (trans. from the Portuguese). The persistence of var. *africanum* in the area of closed vegetation up to the middle of the nineteenth century, and the variation in lint quality in the present wild population, are good evidence that var. *africanum* was until recently a cultivated plant. There is nothing to show the source whence it came, or the time of its introduction, but primitive perennials, that might well represent a type ancestral to both *acerifolium* and *africanum*, are still cultivated in the Mekran region of southern Baluchistan (Ansari, 1941).

Among the New World cottons, the African forms of *G. hirsutum* var. *punctatum* are similar to those found on the coasts and islands of the Gulf of Mexico and in the Bahamas. The people with the best facilities for introducing them to the Senegal-Gambia coast were the Spaniards and the British. The Portuguese had no New World possessions within the *punctatum* area, so they are not likely to have been responsible. The French introduced *punctatum* into Réunion, or Bourbon, and this line may well have given rise to the *punctatums* of Madagascar and the Tanganyika coast.

The introductions of *G. hirsutum* var. *marie-galante* and of the Upland cottons are comparatively well documented, and both dates and sources can be given with some confidence. It is, therefore, possible

to observe the nature of the changes that have followed establishment in Africa, and to form a good estimate of the rate at which they proceeded.

The simpler case is that of *marie-galante*, which is almost certainly descended from introductions by the Basle mission. In the southern Gold Coast forest region, and especially where it was first established, the types found are very similar to those of the West Indian islands from which they came. The population is uniformly almost glabrous and, so far as it has been tested, blackarm susceptible, therein resembling the parental type. The variety spread through the forest region to the orchard bush and long grass savannah country of northern Ashanti and the Northern Territories, where jassid is a pest and blackarm a serious disease, and acquired genes for resistance to both that were apparently very rare in the original stock. Crossing between *marie-galante* and *punctatum* is reduced by the fact that in the region where they meet one is grown as a long-lived perennial and the other as an annual. Nevertheless, they do sometimes occur together, and their vigorous F_1 hybrids and fertile later generation segregates can be seen in the field. Blackarm resistance was probably acquired from *punctatum* by gene transference through such hybrids, and an observation by officers of the Gold Coast Department of Agriculture at Tamale, that there is considerable variation in fruiting habit in the northern *marie-galantes*, indicates the presence of other genes from *punctatum* also. Hairiness, on the other hand, must have been built up by the natural selection of genes in the original stock.

The *marie-galante* cottons are large, long-lived perennials, which do not go through a generation every year. Nevertheless, since their introduction in 1843 they have spread through the forest belt and into the savannah country, and have there evolved a locally adapted type. This indicates a remarkably rapid adaptive change, which may be contrasted with the failure to establish Upland cottons in the same area, in spite of an intensive and well-directed programme of research. Following orthodox plant-breeding principles, selection in the Uplands was limited to a rather narrow range of types, and it can now be seen that such a policy would effectually prevent the acquisition of blackarm resistance by introgressive hybridization from *punctatum*.

The northward spread of the *marie-galante* cottons brought them in contact with *barbadenses* from Togoland as well as with *punctatums* from the north. The interspecific hybrid between *marie-galante* and *barbadense* occurs freely, and F_1 hybrids, which exhibit considerable hybrid vigour, can easily be found in fields containing a mixture of the two types.* A most convincing demonstration of hybrid vigour

* Though Stephens (1946) reported that the two West African strains of *G. barbadense* tested were corky " carriers," no " corky " rogues were seen in the Gold Coast, though many hybrids were examined, and a lookout was kept for them.

is given by the occurrence of abandoned fields bearing a heavy growth of tall grass, in which a few flourishing F_1 hybrids overtop the grass cover, and the only other evidence that the field carried a cotton crop is provided by a few miserable, smothered individuals of the parental types. Later generation segregates are rare, and when found are small, often morphologically abnormal, and generally unfruitful, and the cross has contributed nothing to the development of the local cottons.

The introductions which gave rise to the Upland crops of the African savannah regions were made in the early years of the present century. Local adaptation has gone on for about forty generations, and the types now grown are distinct from the modern commercial cottons of the American Cotton Belt in a number of important agricultural characters. They have, in general, rather smaller bolls than American types, and tend to set their crop slowly and, given favourable conditions, over a long period, thereby ensuring better recovery from pest attacks than is possible with quick-cropping varieties. They are of superior quality, both on account of the high quality of the varieties originally introduced and because of the standards set by those who have worked on them since. Their content of jassid resistant and blackarm resistant types is relatively high. These characters distinguish them as a definite geographical race, with sufficient adaptive advantage to enable it to withstand competition from more recent introductions of other races. Other cottons may, by hybridization, contribute useful characters to the commercial Uplands of the African savannahs, but it is unlikely that any of them will prove well enough adapted to be used in direct replacement of a local African Upland stock.

There have been two main contributions to differentiation in Africa: hybridization with *punctatum* and adaptive response to natural and human selective forces. Hybridization with *punctatum* has been common in West Africa. When Upland was first introduced, *punctatum* was already well established, and it was only replaced gradually, so in the early years seed mixing was unavoidable. At the present time, though *punctatum* has been banished from the commercial Upland area, it still supplies the native textile industry in adjacent districts, and some seed mixing still occurs. The intervarietal hybrids and their segregating progeny are fully viable, and rapidly cause serious deterioration in the quality of the Upland crop unless careful control is exercised over seed supply. Nevertheless these hybrids have been valuable in the past. Knight and Hutchinson (in press) have shown that the blackarm resistance of such commercial West African varieties as N'Kourala in the Ivory Coast and Allen in Nigeria was acquired by gene exchange with *punctatum*.

The chief consequences of natural selection have been the increase

in the crop of types resistant to blackarm and jassid, and the main successes of plant breeders have followed from the further development of these natural adaptive trends. The isolation of resistant strains has provided such successful crop varieties as U4 in southern Africa, BAR SP84 in the Sudan, 26C in Nigeria and the new Ukiriguru stocks in Tanganyika. Concentration on high quality has given BP52 in Uganda.

Cotton growing in the Congo was established on modern American varieties such as Triumph and Stoneville. These are of lower quality than those of the British colonies, and are of the big-bolled, quick-cropping type. They are not resistant to blackarm and have little of the hairiness that gives protection against jassids, but in the Congo cotton areas, especially those of the forest belt, neither blackarm nor jassid assume the importance they have in the savannah tracts.

The Uplands of the African savannahs resemble those of India. Both are descended from introductions of the pre-boll-weevil American cottons, and both have preserved the rather slow fruiting habit that makes possible a good recovery from pest attack. Resistance to black-arm and jassid attack is important in both, and was early developed in the Indian stock. The Indian varieties, however, are of lower quality than the African, and this is the main obstacle to their use in Africa.

In *G. barbadense* the types to which the names *peruvianum* and *brasiliense* have been given are common in Brazil and the West Indies, and they were probably introduced into Africa by the Portuguese. The *vitifolium* race resembles the cottons of western South America, and is therefore more likely to have come into the hands of the Spaniards. There can be little doubt that they were introduced by the early European traders on the Nigerian coast adjoining their present distributions. The *vitifoliums* came in by the Niger delta direct to the forest region. The *peruvianums* are known to have been the cottons of the Abeokuta-Meko region until Meko was taken over as an Ishan A multiplication area, and they probably reached the Abeokuta-Oyo region from the coast in the neighbourhood of Badagry. Crossing between the two races is reduced by the difference in their ecological preferences, but where they meet, and where the Ishan A selection from *vitifolium* has been distributed in the *peruvianum* area, free hydridization occurs. The third form of *G. barbadense*, the kidney-seeded var. *brasiliense*, has not become established in a distinct area, and gene exchange between it and the dominant *vitifolium* and *peruvianum* races has gone so far that the kidney gene is the only distinguishable relic of the variety still to be found.

The chief importance of the *barbadense* cottons of West Africa lies in their contribution to the ancestry of those of Egypt (Dudgeon, 1917). The development of the Egyptian cottons from *vitifolium* ×Sea Island

hybrids ranks among the great agricultural achievements of modern times. Jumel's *vitifolium* was a perennial, and its establishment in Egypt as a commercial crop made perennial irrigation necessary. Canals were deepened to maintain the flow of water at low Nile, and *sagias* (Persian wheels) erected to raise it to the level of the cotton fields. The possibility of a barrage and high-level canal system was considered, and the wealth brought in by the new crop provided the necessary capital for investment. So the transformation of Egypt from flood to perennial irrigation began. Once started, it continued despite the replacement by annual varieties of the perennial cottons which first made it necessary. Moreover, the market continued to expand, and to absorb the expanding crop at prices that made possible even greater capital investment, so that not only has Egypt been equipped with perennial irrigation, but its benefits have been extended to the Sudan Gezira, and even more ambitious projects for the control of the Nile waters are now under consideration. All these developments were interdependent. They were started by the establishment of the cotton crop in Egypt, and financed by the wealth it brought to the country, yet the modern Egyptian cottons could never have been developed without a revolution in Egyptian agriculture, and a vast extension of the market for fine cottons.

The Egyptian race is *par excellence* the cotton of heavy-cropping irrigated land. It has been a failure whenever it has been tried under rain-fed conditions, but given regular watering, high soil fertility, and comparative freedom from major pests and diseases, it has no competitors. In this it reflects the conditions under which it was evolved. In other respects, its ancestry is evident. It is susceptible to blackarm, leaf curl, and jassid, as are the two parent races. The annual habit, and much of the quality of the lint, came from Sea Island, but something of its lint character came from *vitifolium*. Taxonomically, Egyptian cotton belongs to a New World species, but although the introduction of *G. barbadense* into Africa is such a recent event, the race is, by all evolutionary criteria, native—one might almost say endemic—in the Nile valley.

4. Conclusion

It has been argued elsewhere (Hutchinson and Stephens, 1947) that cotton was developed in domestication to meet man's need for a textile raw material adapted to growth and use in the tropics. Evidently its spread in Africa in the last few centuries has been governed by the same interdependence between man and his crop plants that first brought it into being. Races that were brought in early and abandoned in favour of later, more profitable, introductions persist as insignificant occupants of his house-yards and clearings, or as weeds in his crops of more favoured types. Those that suit him best have been spread over wide areas, and have added to their variability by gene

exchange with related types from which they were formerly isolated. Under the selective forces, natural and human, that operate in their new areas, they have evolved distinct locally adapted forms. So fast has this development proceeded that the Egyptian cottons, which are the most advanced, may justifiably be described as native in Africa, though the species to which they belong was introduced from America in recent times. On the other hand, the successful spreading, developing species have at times broken the bonds of domestication and established themselves, first in the ruined vegetation that marks the trail of man's agricultural progress, and then as full members of natural plant communities.

5. Summary

1. Two types of *G. arboreum* are established in Africa, race *soudanense* in the Sudan and West Africa, and race *indicum* on the Tanganyika coast, and formerly in Zambesia.

2. Of *G. herbaceum*, the annual typical form was the first cotton of the Nile Delta. The perennial var. *acerifolium* was the cotton of the Moslem empires of West Africa until the introduction of New World species. The perennial var. *africanum* is established in natural vegetation in South Africa, but reasons are given for believing that it was formerly cultivated.

3. *G. hirsutum* var. *punctatum* is well established throughout the West African savannah region, and is also to be found on the Tanganyika coast. Var. *marie-galante* is common in the Gold Coast and is recorded from the Ivory Coast. *G. hirsutum* proper, Upland cotton, is the commercial cotton of the rain-fed regions of Africa.

4. *G. barbadense* occurs sporadically in most parts of Africa, but is only of importance in the forest regions of Southern Nigeria and Togoland, and in the Nile valley. In the Nile valley, the development of the Egyptian cotton crop has involved a revolution in Egyptian agriculture and the evolution of a new, annual race of *G. barbadense*.

5. The development of distinct African races of introduced cottons is discussed, and compared with the development of the acclimatized race of Upland in India.

6. The interdependence between man and his crop plants is emphasized, but it is pointed out that some cottons still retain the capacity to escape from domestication, and to establish themselves in suitable situations in natural vegetation.

6. Acknowledgments

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COTTON GROWING AT ZEIDAB, NORTHERN SUDAN, AND THE CONTROL OF *LAPHYGMA EXIGUA*

BY

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Introduction

Zeidab is one of many pump irrigation schemes in the Northern Province of the Anglo-Egyptian Sudan. It draws water from the Nile and lies on the west bank of that river about 175 miles north-east of Khartoum in latitude 17° 30′ N. and longitude 33° 55′ E.

Cotton was once an important crop on Northern Province pump schemes. During the past ten years, however, it has been largely abandoned in favour of food crops and fruit trees. Zeidab is now the only pump scheme between Khartoum and Wadi Halfa which grows no cash crop except cotton.

The Zeidab crop is all long staple American Upland (*Gossypium hirsutum*), of which about 5,000 acres are grown annually. A large-bolled, quick-maturing, modern variety is used, namely, " Wilds 11," produced by the Coker Pedigree Seed Company and introduced direct from the U.S.A. to the Sudan.

Cotton pests are a major factor at Zeidab. Diseases appear to be of lesser importance. The present practice of planting in the first half of May is due to Pink Bollworm (*Platyedra gossypiella* Saund., Gelechiidæ), which is said to make cotton production impossible after October. The crop is sown early to be picked before the main attack develops. Rapid and efficient establishment of the crop, essential for high grade and yield, can be hindered by the Cotton Seedling Worm (*Laphygma exigua* Hb., Noctuidæ), which may destroy hundreds of acres of young plants. Control of *Laphygma* by cultural methods is discussed below.

General Description of the Zeidab Scheme

The scheme, which was owned by the Sudan Plantations Syndicate from 1907 to 1949, takes its name from Zeidab district and island. The latter is small and is separated from the west bank of the Nile by a dry channel which fills during the annual flood. This channel is dammed and bridged by the main irrigation canal running west from the pump station on the east or river side of the island.

The scheme has a gross area of nearly 24,000 acres, of which only 15,000 acres are used for cotton. It does not include the Nile bank

fringe of riverain cultivation or any cultivation on Zeidab island, all of which belongs to native farmers. Starting west of this Nile bank fringe, the scheme runs for several miles across a flat clay plain bounded to the west by low flat-topped hills. Beyond are the western deserts of the Northern Sudan which merge into the great Libyan desert.

The scheme may be divided into three main areas of cultivation:

(*a*) Timerab to the north with an annual cotton crop of 1,100 acres.
(*b*) Zeidab in the centre with an annual crop of 3,300 acres.
(*c*) Rau Extension to the south with an annual crop of 600 acres.

A small part of the crop in the Zeidab area and the Rau Extension is grown not on the scheme but in the riverain fringe where farmers take water from the scheme and in return grow cotton.

The scheme is run by four British inspectors and a British engineer, in addition to other Greek and Sudanese staff. The cotton is grown by Sudanese tenants on land allocated to them, using water provided by the scheme. The tenants receive half the value of the cotton they grow and are also given a free allocation of land and water for millet (*Sorghum vulgare*) cultivation in the winter. The cotton belongs to the scheme, the millet to the tenants.

Climate

Meteorological data for Zeidab are not available. Statistics given by the Sudan Government Meteorologist* for Atbara, which is close to the northern end of the scheme, show the climate to be hot and dry with a mean annual temperature of 29·5° C., a mean annual rainfall of 70 mm. and a mean annual 8.00 a.m. relative humidity of 29 per cent.

The winter months of November—March are relatively cool with a mean temperature of 25·6° C. and occasional minimum temperatures as low as 4·5° C. The summer months of May—September are hot with a mean temperature of 33·6° C. The cotton is grown in these months and data for them are given in the following table:

	Mean Daily Screen Maximum °C.	*Mean Daily Screen Minimum* °C.	*Mean Daily Temperature* °C.	*Mean Rel. Hum. 0800 Hours* %	*Mean Rainfall* *mm.*
May	41·9	25·0	33·4	18	3
June	42·8	26·7	34·8	18	2
July	40·6	26·5	33·6	28	18
August	39·7	25·7	32·7	38	38
September	41·0	26·1	33·6	29	6
Mean	41·2	26·0	33·6	26·2	Total 67

* *Agriculture in the Sudan*, by J. D. Tothill *et al.*, pp. 73-83. Oxford University Press, 1948.

Most of the annual rainfall occurs in the second half of the summer. It is, however, too light and too uncertain to be of much, if any, benefit to the crop. In fact, heavy showers after the end of August can do appreciable damage to seed cotton in open bolls awaiting picking.

During the winter the prevailing wind is from the north. In April and May this north wind slowly dies away. During June and early July very hot dry winds may blow from the deserts lying to the west and north-west. These are much feared as they damage the crop. On July 2, 1948, while they were blowing, many very young bolls were shed. No sign of damage could be seen and presumably shedding was due to water-strain. The bolls so lost were among the first to be produced.

During July the summer rains arrive with a prevailing south wind. They continue throughout August. At Zeidab, except for occasional thundershowers, their effect is little more than a rise in humidity accompanied by violent dust storms.

In September the south wind dies away and the humidity falls. In October the north wind arrives with lower temperatures. In November the winter begins.

The Crop and its Management

Some 15,000 acres of the best land of the scheme are reserved exclusively for cotton. They are cropped on the three-year rotation of cotton, fallow, fallow. The rest of the scheme is left uncultivated or is used for millet production in the winter.

The soil is a heavy brown clay. Poorer patches are lighter in colour. Ammonium nitrate is used extensively. It is applied after first irrigation at about 100 lb. per acre.

Cotton is planted in the first half of May in two stages called first and second watering. About half of each area of the scheme is planted on first watering and the other half is planted about a week later on second watering.

The crop is theoretically spaced at 40 cm. between plant-holes on ridges that are 80 cm. apart. In practice the ridges are usually 60-70 cm. apart and the plant-holes as close as 25 cm. Spacing at 40×80 cm. gives about 12,000 plant-holes per acre. Counts made in four places in 1948 showed the average to be about 20,000 plant-holes per acre. The seedlings are supposed to be thinned to 2 per plant-hole. In practice thinning may be neglected and 4-6 plants develop per plant-hole. This lack of thinning, together with close spacing, may result in overcrowding on the richer soil where plants grow more strongly.

Watering intervals are ten to twelve days in May and June and eight days or less during July. From late July onwards the intervals are gradually lengthened again to suit climatic conditions and the state of the crop. In 1948 the last watering was given on November 2.

The variety grown is one of those developed in the U.S.A. to escape boll weevil attack by rapid growth and early maturity. The plants are less than 1 m. high, compact and sympodial in habit. They mature quickly. Flowering in 1948 began forty-two days after planting and boll-splitting started forty-five days after flowering.

A bottom crop is set early in July and ripens during August. Picking begins in late August and reaches its maximum in early September. Four-fifths of the total harvest is usually picked by mid-September, including all the high-grade cotton. While the bottom crop is ripening growth ceases. Once the bottom crop is ripe, growth begins again and a late low-grade top crop is produced.

The bolls are large, decreasing in size as the plant ages. Those of the bottom crop are 35-40 mm. in diameter when fully grown, while those of the top crop are only 32-33 mm. Larger bolls have five locules, smaller ones have four or three locules.

Yields may vary considerably from year to year as is shown by the data given below in the section on *Laphygma*. In a good year the scheme should average 1,250 lb. of seed cotton per acre. The highest recorded yield is 3,230 lb. of seed cotton per acre from a four-acre plot.

Watering usually ends in November and the crop is cut out in December. The land is left untouched in its first year of fallow. In its second year fallow it is broken to a depth of 20-30 cm. by cable-drawn cultivators and is later ridged by hand for planting.

Control of *Laphygma*

The Cotton Seedling Worm, *Laphygma exigua*, is a pest of young plants. Old plants are rarely attacked. At Zeidab, following planting in the first half of May, the peak of attack usually occurs in the first half of June and the attack is over by the end of the same month. Exceptionally severe attacks may go on into July. Damage consists of defoliation and of ring-barking at ground level. In severe attacks hundreds of acres of cotton may be destroyed.

At Zeidab, in the absence of cotton, the pest lives on a wide range of alternate host plants common in the riverain fringe of cultivation. These include Lucerne (*Medicago sativa*), Maize (*Zea mays*), Millet (*Sorghum vulgare*), Okra (*Hibiscus esculentus*), Jew's Mallow (*Corchorus olitorius*), Purslane (*Portulaca oleracea*), and weeds belonging to the Portulacaceæ and the Chenopodiaceæ.

The life cycle on cotton at Zeidab in the summer is as follows. Female moths lay their eggs in groups of twenty to seventy on the lower sides of the leaves of seedlings. Older plants are avoided. The eggs hatch in two to four days and the young grey-green caterpillars feed on the lower surfaces of the leaves. If disturbed they drop off, often remaining

hanging by a thread which they have spun. Otherwise they remain on the plant. As they grow older they leave the plant during the heat of the day to shelter in the soil. They now may behave like cutworms and destroy plants by ring-barking at ground level. The caterpillars pass through four instars in eight to twelve days and then pupate in the soil. Adult moths emerge four to eight days later. From egg to adult takes two to three weeks. During the winter the life cycle may take much longer.

The crop is invaded in May by small numbers of adult moths. Multiplication is rapid and the second generation of caterpillars may cause appreciable damage in the first half of June. If the plants are uniform, healthy and vigorous they may, in spite of the attack, continue to develop, and by late June *Laphygma* will disappear presumably through lack of suitable plant food. If the development of seedlings is retarded in any way, as by excessive watering at too long intervals, or if successional planting maintains fresh supplies of seedlings, the attack will continue to develop and wholesale loss of young plants will result.

Control measures such as flooding to destroy larvæ and pupæ in the soil, handpicking of eggs and larvæ and poison baiting have been unsuccessful.

Examination of past records shows that *Laphygma* has been known at Zeidab since the early days of the scheme, but in the decade prior to 1938 it was only a minor pest. From 1938 to 1947 it was of major importance.

The following table gives average yields of seed cotton in pounds per acre in the Zeidab and Timerab areas (not including the riverain fringe) of the scheme during the ten-year periods 1928-37 and 1938-47:

	Average yield in pounds of seed cotton per acre.			*Average yield in pounds of seed cotton per acre.*	
Year	*Zeidab Area*	*Timerab Area*	*Year*	*Zeidab Area*	*Timerab Area*
1928	1,143	743	1938	1,227	905
1929	1,137	722	1939	1,028	1,269
1930	1,338	1,456	1940	1,016	998
1931	1,452	1,176	1941	764	839
1932	1,392	1,089	1942	758	863
1933	1,597	1,810	1943	926	737
1934	965	857	1944	998	914
1935	1,239	1,043	1945	565	538
1936	1,269	1,332	1946	577	698
1937	1,305	1,004	1947	836	779
MEAN	1,284	1,123	MEAN	869	854

For 1928-37 the Zeidab area averaged 1,284 lb. of seed cotton per acre. For 1938-47 the average was 869 lb. per acre: a drop of 415 lb. For the same decades Timerab area averaged 1,123 and 854 lb. per acre respectively: a drop of 269 lb. In both cases the difference between the

two ten-year periods is statistically significant. Significance is greater in the case of the Zeidab area ($P=0.01$ as against $P=0.05$).

The annual rise of the Nile begins in July, and peak flood is in late August or early September. The scheme is protected by dykes, but even so, a very high Nile may reduce yields by flooding large areas of crop. This happened in 1929, in 1934 and again in 1946.

During 1928-37 the management of the scheme evolved and put into practice a method of planting designed to eliminate *Laphygma*. This aimed at shortening the period in which the scheme as a whole was planted, and at keeping the crop growing quickly and steadily. Its main points were:

1. Large areas were planted dry before first irrigation.
2. First irrigation was completed rapidly and was no heavier than was necessary to give good germination.
3. Second irrigation was also light and followed about ten days after the first.
4. The whole scheme was planted as quickly as possible.
5. Checks to growth by over- or under-watering were avoided.

It was argued that the rapid and even growth obtained by this method of planting would ensure that by the time the pest had multiplied enough to be potentially serious, the crop would be well grown and outbreaks would die away through lack of suitable food.

During 1938-47 the planting method was changed and the main points of the new technique were:

1. Small areas were planted and irrigated immediately afterwards, giving a succession of plantings, and prolonging the period over which planting was being done.
2. Second irrigation was delayed until fourteen days after first irrigation.
3. Both first and second irrigations were heavy enough to waterlog the soil in an attempt to drown any *Laphygma* present.
4. Little stress was laid on getting the crop in quickly.

The 1938-47 period was associated with much heavier *Laphygma* damage than occurred in the previous decade. This may be ascribed to the change in planting technique. Successional planting maintained a sequence of young plants. Over-watering at lengthy intervals checked plant growth. The crop, as a whole, was delayed in a susceptible phase long enough to allow large populations of *Laphygma* to develop. Resulting damage usually necessitated resowing which further prolonged the supply of susceptible plants. Outbreaks so encouraged continued into July and did great damage before parasites and predators and the final shortage of suitable plant food reduced *Laphygma* populations to their normal endemic level.

In 1947 the 1928-37 planting method was reintroduced and by 1948 was fully operative. In the latter year *Laphygma* attack was very greatly reduced, to such an extent that dusting trials with benzene hexachloride gave no results through absence of the pest. In 1948 the average yield for the Zeidab area was 1,155 lb. and for Timerab 1,031 lb. of seed cotton per acre: respectively 286 lb. and 177 lb. above the 1938-47 average.

It is reasonable to deduce that the significant difference in yield between 1928-37 and 1938-47 reflects, in part at least, the greater opportunities for heavy *Laphygma* attack during the latter decade.

In 1948 patches of light attack occurred in the Timerab area, where it is of interest to note that *Laphygma* has always given trouble in certain parts. Timerab has difficulty in getting enough water at planting time owing to inadequacies in the canal system. At peak demand some fields which are awkwardly placed can never be planted and watered in accordance with the 1928-37 method. It is of great significance that it is in these fields that *Laphygma* predictably occurs. In the table of yields given above, the 1928-37 average for Zeidab is appreciably higher than that for Timerab. In the former area *Laphygma* was more fully controlled by planting practice than in the latter. During 1938-47 no *Laphygma* control obtained in either area and yields in both dropped to a common level.

Summary

A brief description is given of the cultivation of American Upland cotton on Zeidab pump irrigation scheme in the Northern Province of the Anglo-Egyptian Sudan.

Heavy attack by the Cotton Seedling Worm, *Laphygma exigua*, with consequent loss of yield, was associated with a long planting period involving a succession of sowings, and with over-watering at lengthy intervals. These practices prevented the crop as a whole from growing away from the attack.

Good control of *Laphygma* was given by shortening the planting period and by watering lightly at frequent intervals, enabling the crop to grow quickly through the susceptible phase before serious attack could develop.

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THE DISTRIBUTION OF WILD SPECIES OF *GOSSYPIUM* IN THE SUDAN

BY

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Introduction.

The genus *Gossypium* is divided into two basic sections: species which have spinnable lint (the true " cottons ") and those which have a short fuzz of seed hairs which remain closely appressed to the seed.[1] Knowledge of the distribution and relationships of the wild species of *Gossypium* is of importance both for the interpretation of the evolution of the cultivated cottons and because many of them possess characters of potential economic value. The best known wild species are those of the New World. In this group *G. thurberi* and *G. armourianum* are resistant to pink and Egyptian bollworms and to the virus disease leaf-curl, and *G. thurberi* carries a factor capable of enhancing the strength of the lint of commercial cottons.

Among the wild species of the Old World, *G. anomalum* is nearly immune to blackarm disease and *G. somalense* is resistant to pink and Egyptian bollworms. These two species are indigenous in the Sudan and, in addition to their interest as possible sources of valuable genes, their distribution in the country is of some agricultural and botanical significance. It seems likely that *G. anomalum* may be one of the original hosts of the Sudan, or Red, bollworm (*Diparopsis castanea*), so that a knowledge of its distribution is desirable from the plant protection aspect. The wild species of *Gossypium* usually have distinct distributions which do not overlap, but *G. anomalum* and *G. somalense* occupy the same territory over a large part of their range and their distributions and relationships have a special interest to the cotton botanist on this account. Their cytological relationships are discussed elsewhere[2]; the purpose of this paper is to describe the species as they are seen in the Sudan and to give an account of present knowledge of their distributions.

Description of Species.

Gossypium anomalum Wawra and Peyr.

Local names for *G. anomalum* are *Gutub, Gid el Gutn, Gutn el Ghazel, Um Gutna* and *Gutn el Khalla*. This species is figured in Plate I, but no botanical details are given here because it has recently been fully

described by Hutchinson.[1] Since Hutchinson's book was written, accessions of *anomalum* have been examined from a wide area. Remarkably little variation has been found—some accessions show minor variations in boll shape, some have somewhat wider leaf lobes

PLATE I.

G. ANOMALUM.

than the type specimen, and over and above this there is minor variability in the degree of hairiness of the leaves and in plant habit.

Gossypium somalense (GURKE) J.B.H.

No local names for *G. somalense* have as yet been noted. Until 1945, when the writer found this species growing on Jebel Merkhayat near

Omdurman and Captain Vinchon sent in specimens from Fada in French Equatorial Africa, it was thought to be confined to British and Italian Somaliland, southward to the Tana River in Kenya.[1] A number of Sudan accessions have now been grown at Shambat and all are remarkably uniform except for slight variations in height and habit.

PLATE II.

G. SOMALENSE RACE SOUDANENSE.

On the other hand, Hutchinson includes five " species " in *G. somalense*, —viz., *Cienfugosia somalensis* Gürke, *C. ellenbeckii* Gürke, *C. brichettii* Ulbrich, *Gossypium paolii* Mattei and *G. benadirense* Mattei—so that considerable variation exists at the Somaliland end of the range. The Sudan and French Equatorial African material is so uniform that it constitutes a " race " for which the name *G. somalense* race *soudanense* is proposed (Plate II).

The following description of the Sudan race was made by T. R. G. Moir, at that time a member of the Sudan Department of Agriculture and Forests, on material collected on Jebel Merkhayat near Omdurman:

"A small perennial shrub up to 1½ metres high, branched from near the base. Bark of the stem whitish-grey, shallowly grooved; bark of twigs reddish brown.

"Leaves spirally arranged, greyish-green, broadly cordate to almost reniform when old, shallowly palmately 3-lobed, the lobes rounded in the older leaves. The young twigs, young leaves and petioles have scattered black glandular dots and are covered with a short fine pubescence of simple and stellate hairs; the older leaves tend to become almost glabrous on the upper surface. Petioles up to 45 mm. long; leaf blades up to 50 mm. long by 65 mm. broad. Stipules linear, caducous, up to 7 mm. long.

"Flowers one or two together on short sympodial axillary branches from the upper leaf axils. Fruiting branches 6-12 mm. long; pubescent, gland-dotted and leafless except for stipule-like scale leaves. Pedicels up to 12 mm. long.

"Epicalyx conspicuous, of 3 deeply cordate bracts shallowly toothed on their upper half; the bracts light green, pubescent at first, gland-dotted, rather variable in size, up to 32 mm. long by 25 mm. broad; each bract with an extra-floral nectary on the outside at the base.

"Calyx cup-shaped, up to 5 mm. deep, shallowly 5-lobed (not toothed), gland-dotted and pubescent.

"Corolla up to 25 mm. long, campanulate; petals light yellow, the lower half strongly blotched with wine red, sparsely gland-dotted towards the tips.

"Stamens small, about 80, united to form a narrowly conical column 10 mm. long; the lowest stamens inserted about 3 mm. from the base of the column on separate filaments 1 mm. long.

"Ovary 3-5 but commonly 4-locular with 2 ovules in each loculus. Style about 16 mm. long protruding 6 mm. from the staminal column, dotted with reddish-brown spots towards the top. Stigmas 3-5, united.

"Capsule obovoid, sharply pointed, up to 13 mm. long by 10 mm. broad, sparsely and faintly gland-dotted and with a scattered pubescence of simple hairs. Loculi 3-5 commonly 4 with 2 seeds in each. The capsule becomes fully open when ripe and falls off together with the pedicel and the persistent papery epicalyx, by which it is completely enclosed.

"Seeds small, fusiform, 6 mm. long, densely covered all over with a firmly attached fine brownish fuzz 3 mm. long."

An interesting point about this race is its adaptation to wind dispersal. The bolls are very small but the surrounding bracts are large and papery; when the boll ripens it falls off and, supported by its bracts, can travel considerable distances on a high wind. The dust storms of the Sudan, with their high winds, provide an excellent means of dispersal.

The Sudan race differs in several important respects from the only other type of *somalense* so far grown in culture, the accession from El Wák in N.E. Kenya collected by D. K. Kevan in 1945. The Kenya type has reddish flowers, smaller bracts, no wind dispersal of bolls, longer internodes and smaller leaves.

Distribution of *G. anomalum* and *G. somalense* in the Sudan

The geographic distribution of perennial types is ecologically meaningless unless considered in its relation to site, soil, and rainfall. Smith[3] has clarified this whole question by his researches on tree distribution in the Sudan. In searching for wild *Gossypiums* his theory has proved invaluable.

Smith considers the following site types to be equivalent to each other in traversing country from an area of high rainfall to an arid zone:

Rainfall	*Loams*
50 in.	A. Hard soil slopes, sheet slopes not readily absorbing water, usually subject to sheet erosion.
	Clays
45 in.	B. High-lying flood plains, flooded by river or rain, inundated for days at a time.
40 in.	C. Low flood plains, inundated for weeks at a time.
32 in.	D. Mounds in swamps, high river banks in swamps.
28 in.	E. *Rahads, mayaas, i.e.*, pools holding water for months.
25 in.	F. Clay plains (*badob*-soil).
	Sands
18 in.	G. Mature sand-plains with flattened dunes.
15 in.	H. Immature sand, new or partly fixed dunes (*qoz*).
12 in.	I. Pockets or small hollows in sand country, valleys with permeable floors.
	Rock and Water Courses
10 in.	J. Hill with rough rocky absorptive surface.
8 in.	K. Large seasonal water-courses.
4 in.	L. Hard plains of grit or rock.
3 in.	M. Small runnels flushing for an hour or two during rains.
nil to 2 in.	N. Banks of perennial streams or rivers.

The distribution of *G. anomalum* and *G. somalense* covers a broad belt across the Sudan between the 5 in. and 20 in. isohyets. The northern, more arid, fringe of this belt runs from *jebel* top to *jebel* top across the northern parts of Khartoum, Kordofan, and Darfur Provinces. Southward, with increasing rainfall, these species are to be found on *qoz* land (fixed low dunes, or ridges, of sand or grit) and, still further south, on mature sand plains. Neither type has as yet been recorded from the clay plains (" cotton soil ") which lie in a belt across southern Kordofan and Darfur extending into Equatoria Province, and this is probably attributable to the effect of grass fires. In the British Museum, however, there is a specimen collected by A. F. Broun in 1910 from Meshra el Zeraf in the neighbourhood of Malakal. This is recorded in Broun and Massey's flora[4] as *Cienfugosia digitata* and it is clear that it had been regarded as belonging to what is now called *G. anomalum*. The writer recently examined this specimen. It is in poor condition, but there can be little doubt that it is *G. somalense*, though it differs from the typical Sudan race. The type has not since been collected and there is no record of the ecological habitat, but since the rainfall in this region is some 30 in. the species might be expected to occur on Dr. Smith's sites " A " to " D."

As an aid to those searching for these wild *Gossypiums* four typical sites are described below:

Jebel Merkhayat (*c.* 15° 35′ N.; 32° 20′ E.) comprises a group of hills composed of Nubian Sandstone and having a rugged broken surface. In summer, these hills appear almost devoid of vegetation and even after the rains (July-August) vegetation is very sparse. Rainfall in this area is variable but averages some 5 in. a year; shade temperatures are high, being 100° F. or more for over two-thirds of the year. Both *somalense* and *anomalum* grow on the tops and upper slopes of these hills, in crevices, at the sides of gullies and at the foot of vertical rock-faces measuring 4 ft. or 5 ft. in height. At one point the two species occur within 4 ft. of each other. The younger plants of both species cover a wider range of micro-habitat, but old plants are only found where conditions are such as to give maximum value to the scanty rainfall.

Jebel Katul. *G. anomalum* occurs at about 14° 13½′ N.; 29° 21′ E. on a spur of porphyry, well jointed, and having small rock pools during the rainy season. The plants are growing on a well-drained 15° slope with steeper sides. *G. somalense* occurs on the north side of the main valley, at about 14° 14′ N.; 29° 23′ E., just at the foot of a rocky slope at the edge of a sandy gravelly plain which, though well-drained, would hold water for some time after rain. The rainfall in this area would average about 12 in.

Jebel Abu 'Asal. *G. somalense* grows at 14° 15′ N.; 29° 13′ E., in the neighbourhood of a small seasonally flowing gully. The soil is reddish *qoz* sand, 3 ft. deep. Nearby, on the scree of a syenite hillside, other plants of *somalense* occur, but whereas those on the sand are about 4 ft. high those on the scree are only 12-18 in. The former site would be moist for weeks after rain, and being close-packed fine sand, would retain some moisture until mid-spring. The scree would probably dry out more quickly. The rainfall at Jebel Abu 'Asal is about 12 in. a year.

Fertangul (*c.* 20 miles south of El Obeid). In the neighbourhood of this village and about a mile to the west of El Obeid-Dilling Road, some 200 plants of *G. anomalum* were found growing thickly in a slight depression in a sandy plain where water was said to stand for about three hours after rain. The plants were well-grown, the tallest being 8 ft. high. There are reputed to be a number of similar *anomalum* sites in the vicinity. Further south, at Hamadi, *anomalum* is said to grow on a clayey soil near seasonally flowing gullies, but the writer has not seen specimens from here. Rainfall at Fertangul averages some 16 in. a year.

Discussion

One point of interest which emerges from the foregoing account is the variability of *G. somalense* in and around Somaliland and its uniformity throughout the remainder of its range, as at present known, from Jebel Ibrahim Kabbashi, some 25 miles north-east of Khartoum, to Fada in Ennedi Province, French Equatorial Africa. This suggests Somaliland as the centre of origin of the species. At the northward fringe of its range the distribution of *somalense* on *jebel* tops separated by many miles of desert has resulted from its recession to the *jebels* in the era of desiccation following the last pluvial period, which occurred about 4,000 years ago (the *jebel* tops being a wetter habitat in terms of available moisture than the plains). Clearly then the Sudan race of *G. somalense* has not changed appreciably since the last pluvial period, despite its spatial isolation in a series of localized groups of plants. The type must have achieved considerable homozygosity several thousand years ago and the balance between it and its environment is now so fine that probably almost any mutation is disadvantageous. The status of *G. somalense* is almost that of a relic species.

The link between the Somaliland and Kabbashi-Fada occurrences is vague. *Somalense* may have spread in a north-westerly direction from its centre of origin and Broun's specimen from Meshra El Zeraf may represent a relic stepping-stone on this route. This would account for Broun's plant not being typical of the Sudan race. The neighbourhood of Meshra El Zeraf needs examination by a botanist in the hope of re-collecting an aberrant *somalense* there. The alternative possible

route of spread of this species from Somaliland to the Sudan is along the coastal areas of Abyssinia and Eritrea, up the valley of the Baraka river and down to Kassala Province by way of the Gash valley. Against this route is the fact that the most north-easterly Sudan record is from an area only 25 miles north-east of Khartoum. The region between Khartoum and Eritrea has not, however, been adequately examined as yet and it may well be that *somalense* occurs there.

The most easterly record of *G. anomalum* in the Sudan is Jebel Merkhayat near Omdurman, but Steudner, Hildebrandt, and Schweinfurth all record this species in the neighbourhood of the upper Baraka river in Eritrea.

It is hoped that botanists in Abyssinia, Eritrea, and the north-eastern Sudan, and in French Equatorial Africa, will look for *G. somalense* (and *G. anomalum*) in likely habitats and send specimens and seed addressed to the writer at Shambat, near Khartoum, Sudan.

ACKNOWLEDGMENTS

It is a pleasure to record my thanks to Messrs. G. Andrew and G. Yanni Karkennis of the Sudan Government Geological Survey for their assistance in sending in specimens (with descriptions of the habitat) of wild *Gossypiums* from several Kordofan and Darfur sites. Also, this article owes much to discussions with Dr. J. B. Hutchinson, whose help I acknowledge with thanks. The illustrations appear by courtesy of the Sudan Government from their publication, *The Flowering Plants of the Anglo-Egyptian Sudan*, vol. ii, by Dr. F. W. Andrews.

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APPENDIX

LIST OF SITES OF *G. anomalum* AND *G. somalense*

G. anomalum

N. of Mellit, 14° 14′ N.; 25° 41′ E.
N.W. of Abyad, 13° 51′ N.; 26° 18′ E.
Nahud Forest Reserve (plentiful).
Gibril, 12° 50′ N.; 28° 13′ E.
N.E. of Hamra, 12° 51′ N.; 28° 48′ E.
Jebel Katul, 14° 13½′ N.; 29° 21′ E.
Fertangul, *c.* 12° 55′ N.; 30° 05′ E.
E. of Jebel Haraza, 15° 14′ N.; 30° 35′ E.
Semeiha, 12° 40′ N.; 30° 50′ E.
Jebel Tuyus, 14° 20′ N.; 31° 33′ E.
J. Merkhayat, *c.* 15° 35′ N.; 32° 20′ E.

G. somalense

Fada (F.E.A.), *c.* 17° 15′ N.; 21° 40′ E.
Jebel Abu 'Asal, 14° 13′ N.; 29° 11′ E.
Jebul Katul, 14° 14′ N.; 29° 23′ E.
Jebel Abu Sinun, 13° 19′ N.; 29° 56′ E.
E. of J. Haraza, 15° 14′ N.; 30° 35′ E.
Meshra el Zeraf, *c.* 09° 20′ N.; 31° 10′ E.
Jebel Merkhayat, *c.* 15° 35′ N′; 32° 20′ E.
Jebel Ibrahim Kabbashi, 15° 48′ N.; 32° 50′ E.

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NOTES ON CURRENT LITERATURE

COTTON IN INDIA AND IN PAKISTAN

391. Indian Cotton Crop, 1948-49. (*Cotton*, M/c., 2/7/49.) The following statistics are quoted by the Ministry of Agriculture, Government of India, in the fourth forecast of the Indian Union cotton crop: total acreage, 10,873,000 acres; total yield, 1,750,000 bales of 392 lb. each. There is an increase of 2·6 per cent. in area and a decrease of 17·8 per cent. in yield as compared with the corresponding revised figures for last year. The decline in yield has mainly occurred in the Central Provinces and Berar, Bombay and Baroda State. In the Central Provinces and Berar excessive and untimely rains in November caused considerable damage to the crop, which, however, could not be exactly assessed at the time of the third forecast. Although the showers helped in producing fresh buds and bolls, they could not reach a stage of maturity owing to dry and cold weather that followed in December. The Provincial outturn now has been reported to be 43·5 per cent. of the normal, as against 57 per cent. of the normal in the third forecast. In Bombay also the yield has fallen from 226,000 bales reported in the third forecast to 205,000 bales in the current forecast, due to failure of rains since December last. The decrease in yield in Baroda is attributed to complete failure of the 1948 monsoon.

392. India: Cotton Textile Fund Committee. (*Cott. and Genl. Econ. Rev.*, 26/8/49.) With a view to encouraging exports of cotton textiles, the Government of India have reconstituted the Cotton Textile Fund Committee. It may be recalled that the Cotton Textile Fund was inaugurated by a special ordinance in July, 1944, with a Committee to administer this fund. During the war years the mills and exporters made enormous profits on the export of textiles. It was then that the Government decided to levy a small tax of 3 per cent. on the maximum ex-mill price. The amount collected was to be expended on schemes for the welfare of the cotton mill industry. Nothing was heard of the Committee until recently. All that is known is that the fund so far collected amounts to 23 million rupees. This fund will now be utilized for the research and export promotion of textiles.

393. Bombay Cotton Annual, 1947-48. East India Cotton Asscn. Ltd., Bombay, 1948. Price Rs. 4.) The twenty-ninth issue of this Annual gives reliable statistics for crop acreage, production, consumption, exports and all matters relating to the cotton industry in India. A review of the 1947-48 season is included, which gives a comprehensive record of the year's trading and events which affected the cotton market.

394. Indian Central Cotton Committee. Report of the Technological Laboratory, Bombay, 1947-48. The present report contains an account of the work done at the Laboratory during the year ended May, 1948. Fibre tests were made on 1,039 samples, the interesting features of which are described in the Report. Tests were also carried out on the pre-cleaning and ginning of Indian cottons, and investigations of the spinning performance of saw-ginned and roller-ginned cotton are being continued. Several other interesting experiments carried out by the Fibre Testing Section and the department of Technological Research are described.

395. Institute of Plant Industry, Indore. (Prog. Rep. Year ended May, 1948.) In the Plant Breeding Section reports are given of variety trials which were carried out in order to obtain improved strains for specified cotton-growing areas in central India, and for wilt-resistant strains. Experiments conducted by the Genetics Department were designed to show the effects of chlorophyll deficiency, and to evolve seed of Buri 107 of uniform fuzz colour. The effect of agronomic factors on

the yielding capacity of the seed was also investigated. The Agronomic Section contains reports on manurial and rotation trials. Experiments with Methoxone weed killer gave no significant results. Trials with commercial insecticides in dust and spray form also gave inconclusive results. The proposed programme of work on cotton for the year 1948-49 is outlined.

396. Cotton Cultivation in Central India and Rajputana. II. Problems of Improvement. See Abstract 450.

397. Pakistan Cotton Crop Forecast. (*Weekly Pakistan News*, 9/7/49.) The third forecast of the area under cotton for the year 1948-49 is 2,911,000 acres (2,423,000 acres under American varieties and 488,000 acres under Desi) as against 3,139,000 acres (2,648,000 acres under American varieties and 491,000 acres under Desi) reported in the third forecast of the previous year, and shows a decrease of 7·3 per cent. There is a general decrease in the acreage of this crop throughout Pakistan, the decrease in respect of American varieties being 8·5 per cent., while that in respect of Desi is only 0·6 per cent. The estimated yield is 1,046,000 bales (400 lb.) as against 1,210,000 bales the previous year, and shows a decrease of 13·6 per cent.

398. Cotton Industry. (*Weekly Pakistan News*, 25/6/49.) It is expected that the six mills now being equipped in Pakistan will be in production by the end of the year. The Valika Textile Mill, which should be the first to be completed, has not yet begun operating due to delay in the installation of machinery. This mill, in whose capital of Rs. 75 lakhs the Sind Government have a 30 per cent. share, is now confident of producing cloth from its 20,000 spindles and 600 looms by August, 1949. The Abbasi Textile Mill at Rahim Yar Khan, in Bahawalpur State, with 31,800 spindles and 300 looms, is nearing completion, and the management hope to place their produce in the cloth market by September. Four other mills—one at Rawalpindi, another at Lyallpur and two in Karachi—are in the process of establishment. Consignments of machinery have been received, and the installation is expected to be completed by the end of autumn. Some of these mills have ordered large consignments of Japanese spindles, and it is estimated that Japan will supply about 80,000 spindles.

COTTON IN THE EMPIRE

399. Cyprus Agriculture, Investigations and Developments in, 1938-48. By J. McDonald. (Cyprus Govt. Printing Office, 1949. Price 5s.) In 1939 sixteen trials in different parts of the country were carried out comparing the American varieties Coker 100, Clevewilt 5 and Wilds 12 with Mesowhite and the local varieties Triumph and Titsiros. In these trials Coker 100 proved superior to all the others under both irrigated and dry conditions. The experiments were repeated in 1940 and 1941, and served to confirm the superiority of Coker 100. Mesowhite proved to be inferior to the local varieties, and its cultivation was, therefore, abandoned. Between 1942 and 1944, seventeen villages in Nicosia, Larnaca and Famagusta districts were declared "segregated areas" for Coker 100 under the Cotton Law, which meant that only this variety might be grown in those villages. Difficulties in increasing the supply of pure seed, however, prevented further extension of such areas. Since 1941 a nucleus stock of Coker 100 has been maintained at the Central Experimental Farm by re-selection of five single plants each year, the progeny being bulked up each season in order to supply stock seed for the Farm. Cotton irrigation trials at the Central Experimental Farm, extending over three years, were terminated in 1938. They showed that the yield of cotton increased in direct proportion to the amount of water applied up to 40,000 gallons per donum (1,600 sq. yds.) every fifteen days. This quantity was the maximum used in the experiments.

400. AFRICA. Allocation of Grants from the Colonial Development and Welfare Fund. (*E. Afr. and Rhod.*, 28/7/49.) Expenditures and allocations under the Colonial Development and Welfare Acts to March 31, 1949, are set out in a White Paper laid before Parliament, which noted that of £63 million so far spent, about

£41,500,000 has been or will be spent on or in Africa. During the past year grants and loans for the 380 schemes approved within the Colonial Empire were £10,627,509 for development and welfare, and £1,652,169 for research schemes. The largest single item in the East African section of the schedule was £611,000 for soil conservation and agricultural development in Kenya, the grant covering the whole of the estimated capital expenditure and one-third of the estimated recurrent expenditure for the years 1948-55, for the prevention of further deterioration of soil fertility, particularly in the Native areas. In addition, £433,000 was granted for reconditioning Native lands, a number of investigational and pilot schemes in connection with which are to start shortly. Tanganyika received a further £388,433 for development of water supplies as a remedy for the over-concentration of population in the neighbourhood of existing supplies and the depopulation of good land where surface water is not available. For the establishment of a soil conservation organization there was an allocation of £110,104 to finance surveys, research into the effectiveness and practicability of soil conservation measures, planning, education in the subject, and actual schemes of protection or rehabilitation. That sum is calculated to meet the necessary capital and recurrent expenditure for four years. For the continued development of rural water supplies in Uganda there was a grant of £325,000, which should carry on the work until the end of 1953. Nyasaland received £154,250 for agricultural development and soil conservation schemes.

401. Land Development in African Territories. (*Cro. Col.*, September, 1949, p. 584.) Delegations from all British African Colonies and Protectorates have been invited to attend a conference on Land Utilization, to be held at Jos, in Nigeria, from November 7. The conference will consider papers submitted by the participating Governments on reclamation and settlement schemes. Other subjects will include the conservation of water supplies; trypanosomiasis control policy; legislation required to conserve natural resources and for settlement; land tenure; the advantages of the various systems of native development (such as co-operative enterprises, State farms, corporations, etc.); and livestock development.

This conference will be followed by another, of international scope, which will start at Jos on November 17. It will comprise representatives of Britain and the British African territories, France and the French Colonial territories, Belgium and the Congo, the Union of South Africa, Southern Rhodesia, and Portugal and the Portuguese Colonial territories. They will discuss matters affecting indigenous rural economy from many angles, including the adaptation of existing systems of land tenure and of land utilization to improve methods of cultivation; the study of group development; the increase of production and the maintenance of soil fertility; the development of rural industries; and the economic and social development of rural communities.

402. African Cotton Areas: Study by United States. (*Times*, 26/8/49.) The United States Department of Agriculture announces that Mr. P. K. Norris, its principal expert on cotton production, is being sent for a year to Africa to make a first-hand study of the potential cotton-growing areas, and the possible effect of this production on the market for United States cotton. The sending of this mission is evidence of growing American concern over the plans now being made by some major cotton-consuming countries in Europe to rely to a greater extent on African crops than they have done in the past.

403. Cotton in British East Africa. By R. P. Dunn. (Nat. Cott. Council, Tennessee. Pp. 62. 35c.) This report on cotton in British East Africa—Uganda, Kenya and Tanganyika—describes the present system of production and marketing of cotton in these three countries, and the research and improvement programmes in progress or contemplated. It depicts the limitations, difficulties and possibilities of the crop, and endeavours to evaluate its prospects for the near future. The author pays tribute to the valuable research work on cotton cultivation which has been carried out by the Empire Cotton Growing Corporation. This is aimed primarily at developing varieties resistant to the many local pests and diseases and developing strains which are better adapted from the standpoint of yield to the various areas where climatic conditions differ.

404. NIGERIA: COTTON INDUSTRY, 1948-49. (*Half-Yrly. Rpt. to June*, 1949.) Northern Province's purchase of American cotton for export in the year 1948-49 totalled 47,904 bales as against 18,445 bales in 1947-48. The price for Grade I seed cotton rose to 4d. per lb. The cotton acreage was increased this year and the season was very favourable for early sown cotton, except in Southern Katsina. The abrupt cessation of rain, and the early October onset of harmattan, however, caused a high rate of boll shedding, and yields, especially of late sown cotton, were adversely affected. Fortunately the increased acreage largely offset the lower yields, and purchases for export were nearly three times greater than last season. Competition from the local spinning industry was much less severe than it was a year ago.

Multiplication of Strain 26C cotton for general distribution continued, and 160 tons of this seed will replace commercial Allen at the Faskari dump in 1949. As a result of the visit of Mr. J. B. Hutchinson and Mr. E. O. Pearson in 1948, Mr. King, Botanist, has been seconded by the Empire Cotton Growing Corporation, and arrived at Samaru early in May to take over all cotton-breeding work in Northern Nigeria. Mr. Geering, the Entomologist seconded by the Corporation, has completed his preliminary investigations of the distribution and life history of the bollworm and other pests of cotton in that region. He is actively conducting research into practicable methods of control, and of enforcing an effective close season.

Early rains of the current season were uncertain and variable, and the food crops of the cotton belts were generally late planted. It is anticipated that in consequence much of this year's cotton crop will also be late sown. It is, however, much too early to assess acreage and prospects for the season, as everything depends upon the July quarter rains and upon the persistence of the rains after the end of September.

Western Provinces.—Graded seed cotton purchased at Meko totalled 13,489 lb. and was classified as follows: Grade I, 2,626 lb.; Grade II, 7,357 lb.; Grade III, 3,506 lb. Rainfall is reported to be satisfactory for this season's crop in all areas.

405. COTTON IN FRENCH AFRICA AND NIGERIA. By R. P. Dunn. (Nat. Cott. Council, Tennessee. Pp. 71. Price 35c.) This report is intended to describe the present status and discuss the problems and possibilities of future production of cotton and cotton textiles in French Africa, Nigeria and the minor countries of the western "bulge" of Africa. The author estimates that in the agricultural area of this territory there are more acres of potential cotton land lying idle than have ever been planted to cotton in the entire Western Hemisphere. Despite these resources, however, development in cotton production is expected to be slow. The present production of commercial cotton in the area is only 153,000 bales. Local authorities predict that if all factors are favourable production may be doubled in another five years, but that it will take another 15 or 20 years before this area could be expected to produce as much as one million bales. In general, where the land is suitable and available, the population is insufficient to expand production rapidly. Conversely, where the population is adequate the land is not available. A further problem in the utilization of tropical soils is maintenance of fertility. Statistics are given for production and export of cotton for individual states, and the report contains much useful information on prevailing geographical and political conditions in so far as they affect the cotton crop.

406. NYASALAND COTTON CROP. (Dept. Agric., July. From *Cott. and Genl. Econ. Rev.*, 22/7/49.) The severe drought experienced earlier in the year has had serious repercussions in respect of the cotton crop. When the rains eventually broke in March, agricultural activity was entirely directed to the planting of the maximum acreages of food crops, and not until this had been accomplished were issues of cotton seed permitted. Cotton planting consequently took place from 2-3 months later than usual and was inevitably restricted in extent. The crop has progressed satisfactorily to date and has reached the flowering stage, but good yields will depend upon reasonable summer rains. A first provisional estimate of the Native Trust Land crop in the Southern Province is 2,400 short tons of seed cotton as compared with the average for the past three years of 5,553 tons. Drought conditions are responsible for the almost complete failure of the crop in the Central Province, where only approximately 30 tons are expected to be marketed. The Northern Province crop is now being planted.

407. SOIL CONSERVATION IN NYASALAND. See Abstract 448.

408. SOUTH AFRICA: COTTON INDUSTRY. (*Ann. Rpt. Emp. Cott. Grwg. Corpn.*, 1947-48.) The acreage planted to cotton for the 1948-49 season was approximately three times that of the previous year. Good rains gave the crop an excellent start, but the drought which followed was very severe and will have affected the yield considerably. In the Barberton area the drought extended from mid-November to mid-January, but whereas crops such as maize were killed, cotton made a remarkable recovery. Further drought in March and April has, however, caused the crop to close down prematurely.

The Experiment Station at Barberton is to be handed over to the Union Government at the end of the 1948-49 season, and with the gradual transfer of staff, the scope of the work has naturally been restricted during the last few years. Work has been concentrated mainly on the detailed crossing programme which was started some years ago, and an indication of the results so far achieved can be obtained from the fact that some of the U.4 × Sea Island strains yielded at the rate of over a bale of lint per acre while possessing much longer and finer lint than U.4. Laboratory studies have been undertaken with a view to evolving simple and rapid methods of estimating leaf hairiness, fibre weight and percentage of short fibre, while promising results have been obtained from trials of Goldthwait's staining technique for immaturity.

409. SOUTHERN RHODESIA: COTTON EXPERIMENT STATION, GATOOMA. (*Prog. Rpts. from Expt. Stats.*, 1947-48.) Sudan and American bollworms again were the main cause of much loss of crop, both directly by their feeding, and indirectly, in that boll-rotting organisms gain entrance through bollworm punctures. Wet-weather conditions favoured the activities of these organisms. Application of DDT in liquid form resulted in increased yields of seed cotton per acre. Yield results in the Main Variety Trial confirmed those of the two previous seasons—namely, that two 7C's are heavier yielders than 9L34. The former have not such good staple as 9L34, but their issue to commercial cultivation is imminent if the results of large-scale spinning tests prove favourable. Local industry is utilizing an increasingly greater quantity of shorter stapled cotton. It is thought that higher values in seed weight and lint index, in combination with other desirable characters, can be obtained, and this should result in an increase in yield. Such increase would, however, in no way compare with the greater increase in yield which would result if the Sudan and American bollworms could be subjected to effective control.

410. SUDAN COTTON CROP, 1948-49. (*Ann. Rpt. Emp. Cott. Grwg. Corpn.*, 1949.) *Sakel Cotton.*—The total area planted to Sakel type cotton amounted to 307,241 feddans, of which the Gezira area planted by the Sudan Plantations Syndicate and the Kassala Cotton Company accounted for 104,834 feddans of Sakel and 101,944 feddans of X.1730. In the Gezira the crop began well, but was adversely affected by long spells of cold weather and jassid attack. A record low flood reduced the area under cotton in the Tokar Delta to 20,685 feddans, but in the Gash Delta the area planted was 46,537 feddans, and a record crop is expected. All Government Schemes and private estates were sown with X.1730A cotton this year, the combined area totalling 33,241 feddans.

American Rain-grown Cotton.—There was a further increase in the area planted, which reached a total of 65,806 feddans in Kordofan. With the exception of 8,000 feddans in the Lagowa area, the variety grown was Bar SP.84. The crop made a good start, but the early cessation of rains reduced the yield.

General.—In 1947-48 an area of nearly 5,000 acres of Domains Sakel, Selection No. 1 (D.S.I.), a strain selected by Mr. Evelyn, was grown by the Sudan Plantations Syndicate, and a further 4,800 acres were grown in the Gash for propagation. D.S.1 gave a higher yield per acre and produced a greater percentage of Grade 1 seed cotton than the Commercial Domains Sakel. A further item of importance was the appearance in the breeding plots in the Gezira, for the first time, of a blackarm-resistant Domains Sakel, on which further work will be carried out. Work on blackarm and leafcurl resistance in the 1730 series was continued, and further selection was made in X.1530 to produce a jassid-resistant type. The work of the Economic Geneticist at Shambat dealt mainly with breeding for resistance to black-

arm and jassid, but trials were also continued to transfer a measure of bollworm resistance from wild to commercial cottons.

In the rain-grown areas in the south, which are served by the Kadugli Station, a big increase took place in the areas growing Bar SP.84, a blackarm-resistant strain derived from the Barberton U.4. Sufficient seed of this variety was available to plant 66,000 acres in 1948-49, and competent observers say that if the present price to the cultivator is maintained, a crop of 25,000 bales should be reached by the season 1949-50. Bar SP.84, although the lint is slightly more immature and neppy than Pump Scheme Strain, is markedly superior to it in yield, and is earlier, more resistant to blackarm and jassid, and has a higher ginning outturn.

411. COTTON INDUSTRY. (*E. Afr. and Rhod.*, 30/6/49.) In a statement to the House of Commons the Foreign Secretary said that the value of raw cotton exported from the Sudan during 1948 was £E16,100,000. The value of cotton cloth imported into the Sudan during the same period was £E14,600,000. Cotton cloth was not yet being manufactured on a significant scale in the Sudan, but it was expected that a mill with an annual capacity of 3,600,000 yards would be ready to operate in 1950.

412. THE PRODUCTION AND CHARACTERISTICS OF THE WORLD'S COTTON CROPS. (*Shirley Inst. Memoirs*, xxiii, 1949.) PART III. SUDAN. By E. Lord. In his introduction the author writes: "The object of this series of papers is to provide a general but comprehensive account of cotton and its growth in the different areas of the world. Consequently, this paper gives not only a full description of the commercial Sudan Sakel and Sudan American crops, but also provides many details of other strains as yet in the experimental stages of development in the Sudan. The information regarding the former cottons is mainly of use to the spinner; the latter cottons are more particularly of interest to breeders and growers in the Sudan and also in countries where changes in seed supply are being considered." He reviews the historical background of the Sudan Sakel crop and its development under the management of the Sudan Plantations Syndicate, the Kassala Cotton Company and the Gash Board. The cultivation of American type cottons in Kordofan and Equatoria is also fully described. A section is devoted to the incidence of diseases and insect pests, and the methods practised for their control. The marketing and grading systems are explained and the characteristics of all the commercial strains under cultivation are carefully recorded. A broad outline of the methods of seed propagation and the development of purified seed stocks is included. The author concludes by indicating certain lines of development which appear to deserve consideration.

413. A NOTE ON THE GEZIRA SCHEME, ANGLO-EGYPTIAN SUDAN. By Mohammad Afzal. (*Ind. Cott. Grwg. Rev.*, iii, 2, 1949, p. 92.) In this article the author gives an outline of the organization and agricultural conditions of the Gezira Scheme, together with details of the relationship between the Sudan Government, the tenant farmers and the two concession companies, the Sudan Plantations Syndicate and the Kassala Cotton Company who manage the Scheme. The organization is compared with the Russian Collective Farm system to the advantage of the Gezira Scheme, and the author suggests that similar schemes should be tried in West Punjab and other areas in the Indo-Pakistan sub-continent.

414. COTTON SCHEME FOR THE SUDAN. (*M/c. Gdn.*, 13/8/49.) The Executive Council, Khartoum, has approved proposals for a future Gezira cotton scheme when the Sudan Plantations Syndicate contract expires in 1950. A committee set up in 1947 recommends that the functions of the syndicate be taken over by a Gezira Board, which would be a separate entity with contractual powers responsible to the Executive Council. The proposals will come before the Legislative Assembly later in the year. Mr. A. Gaitskell has agreed to become managing director of the new Board. He is the present manager.

415. SWAZILAND COTTON CROP. (*Ann. Rep. Dept. Livestock and Agric.*, 1947. Received 1949.) Practically no cotton has been grown for some years past, but this year, owing to the high price, a small acreage has again been put down to

cotton in the low veld. At the Croydon bush veld sub-station the cotton variety trial gave useful results, the best yield being 570 lb. per acre of seed cotton—equivalent to 203 lb. of lint. The old bulk strain 5143 yielded only 330 lb. of seed cotton or 120 lb. of lint. A similar trial including eight new strains was planted in the 1947-48 season.

416. TANGANYIKA: CROP PROSPECTS. (*Ann. Rpt. Emp. Cott. Grwg. Corpn.*, 1947-48.) In the Lake Province the planting of the 1948-49 crop was completed in February. The area under cotton is reported to have been increased in some areas by as much as 50 per cent. It is also expected that there will be a larger acreage planted to cotton in the Eastern Province, and given reasonable weather conditions and no undue damage from pests a cotton crop of 12,000 to 15,000 bales has been forecast. Slight increases are also expected in the Southern, Tanga and Northern Provinces.

During the past year multiplication of U.K.46 continued rapidly and over 600,000 lb. of seed were produced. This variety, which has much the same spinning qualities and fibre characteristics as Mz.561, the previous commercial variety, again did well and consistently outyielded the latter. It is hoped that U.K.48, which is now being multiplied, will do even better, as resistance to blackarm has been incorporated and its ginning percentage increased.

417. UGANDA: COTTON CROP. (*Cro. Col.*, August, 1949, p. 510.) The total cotton crop for the 1948-49 season is expected to reach 390,000 bales, including 12,000-15,000 B.R. quality (second grade). Over 200,000 bales have already been shipped. Ginning is expected to be completed in August. Next year's prospects at present are not very good, as rains have not been favourable, and the opening of buying is bound to be later than last year. Uganda expects to export 50,000 tons of cotton seed in 1949, all going to the United Kingdom for oil expression. Some 28,000 tons have already been shipped.

418. WORK OF THE EXPERIMENT STATIONS, 1947-48. (*Prog. Rpts. from Exp. Stats.*, 1947-48.) Detailed examination of BP.52 breeding material indicated that selection advances could still be expected for certain characters, including components of yield. Gene transference projects, including blackarm resistance, seed type and hairiness, were carried a stage further. Summarized yield data for a number of years at Kawanda showed that the highest seed cotton yields may be expected from June sowings. This confirmed the inference from the most recent sowing-date trials.

Two large-scale field trials with fertilizers were conducted during the season. In the first, responses to sulphate of ammonia and rock phosphate were not large. However, a stimulus to germination, and also to plant height at 84 days, was recorded for rock phosphate applied before planting. This early stimulus was not reflected in yield, which was uniformly high for the whole experiment. A new type of ridge was tried at Kawanda for the first time. It is possible that this may have contributed to the high yields obtained in this experiment. The second trial confirmed that the closest spacing led to the highest yield. Also in this trial there was a significant yield response to nitrogen on land newly opened from elephant grass. Analyses of field observations and yield indicated that a part of the observed relationship between *Lygus* infestation and plant height may be due to an early attraction of the more vigorous plants. Also, the index of leaf damage was shown to be related to final yield.

419. COTTON EXPERIMENTAL WORK, 1946-47. (*Ann. Rpt. Dpt. Agr. Exp. Work*, 1946-47. Received 1949.) The Report gives an account of experiments on cotton carried out at the Kawanda Experiment Station in connection with sowing date, district variety trials and resistance to *Verticillium* wilt. Fertilizer trials carried out at Serere to discover the effect of silico-phosphate and rock phosphate on cotton gave disappointing results.

420. CROP STATISTICS. (*E. Afrn. Econ. and Stat. Bull.*, 4, 1949.) The agricultural section of this bulletin contains tables of the main crop production in Uganda and of the price to the producers for crops. The amount produced has been calculated

from an average yield per acre, and the acreages were found by taking sampling measurements in representative districts. The statistics are, therefore, an estimate, but they should be a reasonably good guide to the trend of agricultural production over a period. The average production in the five-year periods 1939-44 and 1944-48 are given. These tables show the increased importance of coffee, groundnuts and maize in the second five-year period and consequently the lesser dependence of the African growers on the cotton crop. The overall picture for the period 1938-48 is one of steadily rising prices, the largest increases being for cotton and coffee, and rapidly expanding production of maize, coffee, groundnuts and tea.

421. AUSTRALIA: COTTON INDUSTRY. (*Ann. Rpt. Emp. Cott. Grwg. Corpn.*, 1947-48.) The whole of the 1947-48 crop of 1,782 bales was sold in Australia, and although the ginning percentage was high, averaging 34·4 per cent., production was less than last year. The 1948-49 crop started off badly, as owing to lack of rain little cotton could be planted until December, and excessively dry conditions in January seriously checked plant development. Although seed for 4,900 acres was distributed, it is doubtful whether 4,000 acres of cotton were effectively established, and this small acreage, in combination with the late planting and erratic conditions, gives little prospect of a good crop. The past season again emphasized the value of irrigation under the irregular climatic conditions of Central Queensland, and at the Experiment Station at Biloela the yield of irrigated cotton was 570 lb. lint per acre, compared with only 46 lb. per acre for rain-grown cotton planted at the same time.

An indication of the complex problems of pest control was obtained from experiments with DDT. When a spray of this insecticide was used to control bollworm, the numbers of aphids and red mites increased considerably, and it was suggested that mixtures should be used in future to guard against such eventualities.

422. WEST INDIES. REPORT OF THE FOURTH ORDINARY GENERAL MEETING OF THE WEST INDIAN SEA ISLAND COTTON ASSOCIATION (INCORPORATED). The report contains the minutes of the Fourth Ordinary General Meeting held at Kingstown, St. Vincent, November 10, 1948. In his address to the meeting the President, Mr. R. B. Allnutt, thanked the members for the welcome they had extended to Mr. I. M. L. Oliver on the occasion of his recent visit to all the cotton-producing islands as representative of the Raw Cotton Committee and of the cotton spinners. As a result of that visit the Raw Cotton Committee had agreed to announce cotton prices at least three months prior to the planting season. The president also drew attention to the valuable work that was being carried out at the Cotton Experiment Station in Antigua under the direction of Mr. J. V. Lochrie, Cotton Officer for the West Indies. The Report of the Advisory Committee in England for the year 1948 and of the Negotiating Committee is also included, together with statistics of cotton acreage, lint production and prices.

423. ANTIGUA: COTTON CROP, 1948-49. (*Cott. and Genl. Econ. Rev.*, 26/8/49.) Ginning in Antigua is almost finished. The total output is expected to be about 2,900 bales, some 900 more than originally estimated.

424. BARBADOS: COTTON CROP, 1947-48. (*Ann. Rpt. Dpt. Sci. and Agr.*, 1947-48.) Seed to plant 244 acres was distributed, but due to adverse weather conditions only 137 acres were reaped. 49,399 lb. of seed cotton were obtained, the total yield amounting to 12,552 lb. of lint. In individual cases the return was good, but in general the yield from peasants' plots was disappointing, averaging only 265 lb. of seed cotton per acre. Very little cotton was grown on the estates, but their average yield was 518 lb. per acre. No pink bollworm was observed in the field or ginnery, although careful inspections were made; this is the eighth year since pink bollworm has been found in the Colony, and it is hoped that this pest can now be regarded as eliminated. The experimental cotton-spinning plant set up early in the year is now producing yarn at full capacity.

COTTON IN THE U.S.A.

425. America: Crop Prospects, 1949-50. (*Cotton*, M/c., 23/7/49.) Excessive rains fell in the Eastern and Central Belts during the first half of July. Temperatures averaged about normal. As a result, the progress of the crop has not been favourable, and the outlook as to yield is uncertain. North Carolina and parts of South Carolina have experienced more favourable weather and progress there has been more satisfactory. In the southern areas of Georgia, Alabama, Mississippi and Louisiana, cotton is fruiting well, with many bolls approaching maturity. In the central and northern areas of these states, and in Tennessee and Arkansas, rains have produced a plant larger and more sappy than normal with plant growth rank at the expense of fruit. Both blooming and fruiting have been retarded. The condition is spotted, with some fields clean but the majority grassy. Fields can be quickly cleaned with good weather, but at this time cultivation averages two weeks late in the central and northern areas. Insect infestation is heavy throughout these belts. Much poisoning has been ineffective because of rains; poison is now becoming scarce and the cost has advanced materially. More weevil damage may develop as a result of shade furnished by the large plant. Abandonment now promises to be considerably more than at first contemplated.

In Texas, Oklahoma, New Mexico, Arizona and California conditions have been favourable and progress has continued good. Fruiting and cultivation are normal.

426. Cotton Crop, 1949-50: Insect Damage. (*Cotton*, M/c., 30/7/49.) The United States Department of Agriculture reports state that weather conditions in all States east of Texas and Oklahoma during June and early July were not favourable for holding the boll weevil in check, and in most areas the situation is extremely serious. One bright spot in the cotton crop situation, the bureau reports, is the fact that no cotton leaf-worms have yet been reported. Every year since 1933 these pests have been reported before the end of June. However, serious bollworm outbreaks have occurred in the lower Rio Grande Valley of Texas and in the Pecos Valley of New Mexico. Although boll weevil infestation in South Carolina Fields is the worst in many years, recent weather has turned favourable for checking the pests.

A summary of conditions in prominent cotton States is as follows: Texas, insects numerous in central and northern districts; rains have interfered with poisoning. Oklahoma, weather favourable for weevils; some grasshopper and fleahopper damage; much poisoning activity. Louisiana, weather favourable for developing weevils; crop damage reported. Alabama, weevil infestation heavy; strong control measures begun. Arkansas and Georgia, weevils increasing due to favourable weather.

427. State Recommendations for the Control of Cotton Insects, 1949. See Abstract 457.

428. Cotton Quality Statistics, United States, 1947-48. (U.S. Dept. Agr. Prod. and Marktg., Cotton Branch, Washington, 1948.) This report contains information on the quality of cotton ginned during the 1947-48 season, and on the quality of cotton on hand in the United States on August 1, 1948. To facilitate comparison, certain data contained in the reports for previous years are included. This information should be helpful to cotton growers and breeders and to merchants, consumers, research workers, and others interested in the quality of the crop and the carryover.

429. Cotton Harvesting by Mechanical Pickers in the United States. See Abstract 453.

430. Texas, Mechanized Production of Cotton in. See Abstract 454.

431. The Competitive Position of Cotton by Major End-Use Markets. Project IV of the Short-Term Fact-Finding Study on the Post-War Agricultural and Economic Problems of the Cotton Belt. (U.S. Govt. Printing Office, Washington, 1947.) The purpose of this project was to develop data on the competitive position of cotton in major domestic end-use markets, and to indicate the extent

to which the size of the market could be influenced by changes in the quality of cotton and its products, in the merchandizing techniques applied to cotton, and in the price of cotton. The main body of the report is presented in four sections. Section I sets out estimates of the size of the domestic market which can be expected for individual end-uses and for the domestic consumption of cotton as a whole in an early year of the post-war period, under the assumptions which have been made. These estimates provide a basis against which the prospective influence of quality, merchandizing, and price can be measured. Section II describes the specific quality characteristics in which cotton and its products need improvement. Section III describes needed improvements in the merchandizing practices and techniques applied to cotton, and indicates the practical importance of each improvement. Section IV is devoted to the influence of the price of the raw cotton fibre. Against a basic assumption of 25 cents per pound which is used in Section I, estimates are made of the extent to which the size of the market would be affected by prices of 12 cents and of 40 cents per pound.

COTTON IN EGYPT

432. Egypt: Cotton Crop, 1948-49. By R. Dabbous. (*Egyptn. Cott. Gaz.*, 7, May, 1949, p. 61.) The final yield of the 1948-49 crop was 1,189,725 bales. The average yield per feddan reached 6·02 cantars of lint, this being an all-time record. The previous highest figure was registered in 1942-43 with 5·82 cantars per feddan, whilst the highest pre-war figure on record was 5·47 cantars per feddan in 1937-38.

433. Cotton Crop, 1949-50. (*Cotton*, M/c., 27/8/49.) The abnormally cooler temperature which prevailed this week favoured the appearance of further cotton-worm larvæ in the Delta, and the situation in a number of fields has suddenly deteriorated, the more so as at this stage the destruction of pests becomes very difficult. It is estimated that 20 to 25 per cent. of the cotton fields in the Delta are contaminated, which raises the possible damage to 10-15 per cent. It is still too early to forecast the possible extent and eventual damage to the crop by the pink bollworm.

434. Today's Cotton Problem in Egypt. By M. A. Farghaly. (*Egyptn. Cott. Gaz.*, 7, May, 1949, p. 7.) The normal and safe proportion between production of long and short staples has been estimated at 25-33 per cent. of long staples and about 70 per cent. of medium and short staples. In the last few years of the war, however, the long staple supply was increased, and, in 1946, made up nearly 73 per cent. of the crop. As a consequence, long-staple prices declined below those of short staples, and even so great difficulty was experienced in the sale of long-stapled cottons. In order to avoid a crisis the Government blocked the sale of long-stapled cottons until the market returned to more normal conditions, but the carry-over is once more mounting ominously. In view of the increasing substitution of long-stapled cotton by synthetic fibres, the author urges that it is in the interest of Egypt to grow the largest possible quantities of Ashmuni and Zagora, and medium staple types.

435. Cotton Exports. (*Cotton*, M/c., 13/8/49.) Raw cotton exports from Egypt from September 1, 1948, to August 4, 1949, total 933,965 bales, compared with 980,913 bales during the corresponding period in the previous season. Great Britain accounted for 315,577 bales against 256,761 bales; the Continent 347,402 bales against 503,055 bales; India, China and Japan 264,935 bales against 158,333 bales, and the United States of America 6,051 bales against 62,764 bales.

436. The Ashmuni Problem. By C. H. Brown. (*Egyptn. Cott. Gaz.*, 7, May, 1949, p. 29.) The future of the Ashmuni crop is discussed in relation to the new varieties which have been evolved in recent years. A description is given of the new types—namely, Giza 31, Giza 50, Giza 54 and Giza 47. Of these Giza 47 gives a substantial increase in yield over Ashmuni and has a yarn strength approximately 20 higher than the latter. It is suggested that Giza 47 might well replace the Ashmuni crop in Upper Egypt.

COTTON IN OTHER FOREIGN COUNTRIES

437. ARGENTINA: COTTON CROP, 1948-49. (*Cott. and Genl. Econ. Rev.*, 19/8/49.) The ginning of the 1948-49 crop has now been completed and it is estimated that the production of lint will be between 85,000 and 90,000 metric tons. Of this total the production of Type A has been insignificant, and of Type B only 7,000 tons, while Type C accounts for no more than 15,000 tons. Several factors have contributed to this disappointing result. Firstly, the seed planted had degenerated in quality through cross-fertilization. Secondly, persistent rains caused an excess of humidity, and thirdly, owing to lack of pickers a good part of the crop was ruined by early frosts. Much of the cotton grading Types C and D is satisfactory in staple quality, but in the very low grades the frost-damaged cotton is very poor in staple strength.

438. DIRECTION DE ALGODON BOLETIN MENSUAL. Jan.-Feb., 1947. (Received 1949.) (In Spanish.) The Bulletin contains estimates of cotton acreage, production and ginning outturn for the years 1945-46 and 1946-47. The quality of the 1945-46 crop is discussed and particulars are given of its grade and staple length. The Bulletin includes an article entitled "Factors Affecting the Longevity of Cottonseed," by D. M. Simpson, and a report on the production and manufacture of cotton in Peru. Statistics of consumption and export are also included.

439. BRAZIL: COTTON CROP, 1948-49. (*Cott. and Genl. Econ. Rev.*, 26/8/49.) Marketing of the current São Paulo crop is now well advanced, and it is estimated that only about 250,000 bales out of the indicated 1948-49 production of 1,150,000 bales still remain to be classified. The world-wide dollar scarcity has stimulated a good demand for Brazilian cotton this season, and prices realised have compared favourably with those quoted for comparable United States qualities in world markets on the basis of official rates of exchange.

Planting of the new crop will begin shortly and soil preparations are already well advanced. Farmers are well pleased with their returns from the past crop and on present indications the area sown will be around one-third larger than a year ago. Given a favourable growing season the coming crop should not be far short of 1,700,000 running bales.

440. BELGIAN CONGO: COTTON CROP, 1948-49. (*Bull. Comité Coton.*, **9**, 24, 1949, p. 13.) In the Southern region production amounted to 68,154 tons of seed cotton, or approximately 22,700 tons of lint. The ginning outturn for 1948 showed an increase of 13·8 per cent. over that for the 1947 crop. This increase is largely due to the change-over in the variety planted from Triumph to GAR. Favourable growing weather and an active propaganda campaign also helped to increase the crop. In the Northern region the total harvest of seed-cotton amounted to nearly 75,000 tons, giving 25,000 tons of lint. This represents an increase of 26 per cent. on the previous season's outturn. Climatic conditions were good for the growth of the crop. The 1949-50 crop in the Southern region is being adversely affected by drought, and despite the continued propaganda campaign and the higher prices offered to growers, it is feared that a harvest as big as that of last season will not be attained. The price paid to the grower for deliveries of seed cotton has been uniformly fixed at Frs. 3.85 per kilo throughout the cotton-growing area except at Kiva and in the Urundi, where it is Frs. 4.70 per kilo.

441. CHILE: COTTON CULTIVATION. (*Cotton*, M/c., 30/7/49.) It is reported that experimental sowings of cotton will be made next spring in the Copiacp, La Serena, Ovalle and Illapel districts of Chile. The potential importance of this step is considerable, in view of the increase and improvement during recent years in the local manufacture of cotton goods. Besides effecting a considerable saving in foreign exchange, the cultivation of cotton should supply valuable by-products for edible oils, soap and cattle-feed cake.

442. CHINA: COTTON INDUSTRY. (*Cott. and Genl. Econ. Rev.*, 22/7/49.) In the first ten months of the current season which began August 1, 1948, it was estimated that cotton consumption in all China was 1,650,000 bales, or an average of 165,000

bales per month. During the three-months period of March, April and May, it was estimated that consumption averaged only about 138,500 bales per month. Most of this decline has occurred in coastal areas where mills are handicapped by a shortage of raw cotton. With the fall of Shanghai, Tsingtao and Tientsin, the Chinese Communist forces have now gained control of 91 per cent. of Chinese operable cotton spindles and nearly all of the cotton-producing areas. Damage to mills from the civil war is believed to be very limited and confined largely to the Tientsin area. Most of the mills are back in operation, but face a serious shortage of raw cotton. Stocks of foreign cotton are low, and raw cotton imports difficult to obtain. The Chinese Communists are making every effort to barter cotton yarn and cloth commodities for raw cotton. It is estimated that 300,000 bales of imported cotton will be required to run the mills, even at the present reduced rate, until the new crop becomes available in October, 1949. There is no shortage of cotton for the smaller number of mills located in the Chinese Nationalist-held areas. The 325,000 spindles under Nationalist control are amply supplied with foreign cotton diverted from Shanghai. Tentative estimates place the 1949 acreage at only 6,075,000 acres compared with 6,284,000 acres in 1948, and cotton production in 1949 is estimated at 2,036,000 bales.

443. Iran: Cotton Crop. (*Cotton*, Monthly Commentary, Inter. Cott. Adv. Ctte., June, 1949.) The 1948-49 crop is estimated at 100,000 bales against last season's production of 80,000 bales. Consumption last season is estimated at 86,000 bales. However, trading conditions have not been favourable to the local textile industry in the current season. Imported textiles have been giving increasing competition and the industry has applied to the Government for assistance. It is reported that the industry's difficulties are due to low cash reserves, the high cost of cotton, worn-out machinery, low output per operative and the need for a higher degree of technical training. The Government is considering ways and means of overcoming these difficulties. So far the resultant increase in availability of cotton is reflected only slightly in exports. They amounted to 4,000 bales in the first half of the 1948-49 season as against 2,400 bales in the first half of 1947-48. Spain and the United Kingdom are the chief destinations this season.

444. Mexico: Cotton Crop. (*Cotton*, M/c., 6/8/49.) Mexico has commenced to pick its 700,000 bales cotton crop, the largest in the history of the country. The year's crop was originally estimated at 600,000 bales by the Mexican Agricultural Department. However, Government inspectors who recently visited all of Mexico's cotton-growing regions said that the crop would be "at least 100,000 bales more than our original estimates." The inspectors credited good weather and scientific use of sprays and chemicals for the increase in crop estimates. It is estimated that 300,000 bales will be warehoused in Mexico for the use of local textile mills, while the other 400,000 bales will be exported.

445. Peru: Cotton Crop. (*Cott. and Genl. Econ. Rev.*, 12/8/49.) It is estimated that the production of Tanguis from the current crop will be less than last year by 20 to 25 per cent.—that is to say, a total crop from the Tanguis valleys of about one million quintals. Leaf worm and "melaza" have caused most damage, and all valleys have suffered with the exception of Ica and Rio Grande, whilst Pisco valley has suffered less than others. The estimated total Peruvian crop is 1,300,000 quintals, which gives about 300,000 quintals for the Piura valley in which Pima is grown—a figure higher than generally expected. It is thought doubtful in trade quarters if such a high yield will be realized, as it is nearly 60,000 quintals above the previous highest.

446. Turkey: Cotton Crop. (*Cott. and Genl. Econ. Rev.*, 29/7/49.) The 1949 cotton acreage in Turkey is officially estimated at 737,000 acres, representing an increase of 10 per cent. over the 1948 estimate of 669,000 acres. A goal of 25 to 30 per cent. above the 1948 figure was not attained because of the late arrival of spring weather and insufficient rainfall at planting time. The 1948 crop was estimated at 235,000 bales, and yields per acre averaged about 84 per cent. of the 5-year pre-war average.

SOIL, SOIL EROSION AND FERTILIZERS

447. THE PRACTICE OF SOIL CONSERVATION IN THE BRITISH COLONIAL EMPIRE. By Sir Harold Tempany. (Aberystwyth: Commonwealth Agric. Bureaux, 1949. Price 10s. From *Nature*, 11/6/49, p. 926.) Factors affecting the incidence of erosion and its occurrence under different types of cultivation are discussed, and various forms of soil conservation are described. Two main methods are recognized, one dependent on the use of earth structure, the other based on the use of cultural practices and living plant material. It is emphasized that soil conservation should not be regarded as a separate end, but rather integrated into systems of husbandry capable of maintaining and enhancing fertility. Besides discussing the problem from the agricultural point of view, attention is also directed to the dangers of erosion around buildings during construction of roads and mining areas.

448. SOIL CONSERVATION IN NYASALAND. By W. J. Badcock. (*Corona*, 1, 8, 1949, p. 15.) Since 1930 the soil erosion problem has been one of increasing importance, and it has been necessary for Government to provide more and more money for meeting it. The first Soil Erosion Officer was appointed in 1935 and attached to the Forestry Department. Later a number of storm drains were constructed, and funds were provided for comprehensive works on a few badly eroded areas. It was not until 1945, following recommendations made by the post-war Development Committee, that really adequate funds were made available for coping with the problem. Since then rapid progress has been made in arresting the ravages of soil erosion by a full-scale programme of contour-ridge cropping and the introduction of a law to enforce destocking where this is essential. Rotational grazing has also been introduced on two important stock areas with spectacularly good results. It can now be confidently asserted that in areas covered by adequate staff serious soil erosion has been arrested, and that in a few instances striking improvements have been achieved.

449. THE EFFECT OF EARTHWORMS ON THE PRODUCTIVITY OF AGRICULTURAL SOIL. By H. Hopp and C. S. Slater. (*J. of Agr. Res.*, 78, 10, 1949, p. 325.) Tests were made to determine the effect of earthworms on the productivity of soil. In five tests, with different crops and soils, earthworms consistently increased yields. Their influences varied widely according to crop and soil. The increases in yield were attributable to the release of beneficial chemical from the bodies of the earthworms and to their physical effects on soil structure. Available evidence suggests that the release of beneficial chemicals occurs principally in the summer season when earthworms normally pass through their reproductive period. Beneficial physical effects on soil structure were obtained on soils where the lack of structure was limiting to crop growth. Benefits from the physical activity of living earthworms were obtained at various seasons depending on favourable soil moisture and temperature, and available evidence indicates that under the field conditions examined, this activity is largely effective during the late fall, winter, and early spring. In one of the experiments, with soil of poor structure, ants produced beneficial effects on yield similar to those of earthworms, an observation which suggests that soil fauna other than earthworms may also be of far-reaching importance to the productivity of soils.

STATISTICAL TREATMENT, CULTIVATION, GINNING, ETC.

450. COTTON CULTIVATION IN CENTRAL INDIA AND RAJPUTANA. II. PROBLEMS OF IMPROVEMENT. By P. D. Gadkari and K. M. Simlote. (*Ind. Cott. Grwg. Rev.*, iii, 2, 1949, p. 75.) The different cotton tracts and the cotton varieties grown in Central India and Rajputana have already been described in Pt. I of this article, and the present section deals with the progress of improvement work that has hitherto been achieved and the future problems connected with it. The work has been carried out at the Institute of Plant Industry, Indore, and, among other results obtained, the following are of interest. A variety known as Indore 2 has

been selected from the M.U.4 strain of Cambodia, which has been shown to give an increased yield of at least 10 per cent. and has better spinning qualities than M.U.4. A new strain called Bhoj has been selected from Malvi 9, having the yield and spinning qualities of the latter, but being, in addition, resistant to *Fusarium* wilt. The cotton work carried out at Ganganagar has resulted in the evolution of Ganganagar I: this variety gives an average yield of 1,300 lb. of kapas per acre.

COTTONSEED AND COTTONSEED PRODUCTS

451. Cotton, New Synthetic Fibres Produced from. (*Cotton*, M/c., 6/8/49.) The United States Department of Agriculture announce that two new synthetic fibres, one made from cottonseed protein and the other from chemically modified cellulose, have been produced experimentally by Government scientists at the Bureau of Agricultural and Industrial Chemistry's Southern Regional Research Laboratory in New Orleans. The cottonseed protein fibre may enable cotton plants to serve as a dual source of clothing and other textile products. It is about three-fourths as strong as wool when dry, feels soft to the hand, and has good dyeing characteristics. Natural colour of the fibre is yellow or light orange. Its wet strength is about 40 per cent. of the dry strength. The other new fibre is spun from sodium carboxymethyl cellulose (a soluble compound made from wood or cotton cellulose) and the salts of certain metals, including lead, copper and aluminium. It is pointed out that neither of these fibres is a competitor of cotton. Their potential future lies in their suitability for special uses.

452. The Value of Cottonseed as Fuel in Tchad. By J. Gautier. (*Cot. Fib. Trop.*, iv, 2, 1949, p. 53.) The production of seed cotton in the Tchad region averages 45,000 tons per annum. The ginning outturn is 29 per cent., and after the necessary amount of seed for replanting has been deducted, a total of 25,000 tons of cottonseed is available for industrial purposes. Owing to the almost complete absence of other combustible material in the Tchad area, and the high cost of transporting fuel to this isolated district, it is suggested that cottonseed could be more profitably used locally as fuel than for other industrial purposes.

MACHINERY

453. AMERICA: Cotton Harvesting by Mechanical Pickers. (*Cotton*, M/c., 23/7/49.) A report based on a study made by the Mississippi Agricultural Experiment Station co-operating with the Bureau of Agricultural Economics, United States Department of Agriculture, states that although harvesting of cotton by mechanical pickers has increased rapidly in the Mississippi Delta in the last few years, machines in use in the area generally harvest only a small part of the total production, and have so far been used only to supplement the hand labour force. Mechanically picked cotton in the Delta cost farmers, for harvesting, the equivalent of \$2.42 a hundred pounds of seed cotton in 1947, when rates for hand picking ranged from \$2.50 to \$4.50. Costs included wastage and grade losses, as well as operating costs. The latter includes out-of-pocket expenses and depreciation and interest on the actual cost of the machine. If based on the higher 1948 price of the machine, the cost to pick one hundred pounds would have averaged \$2.65. Depreciation and repairs account for nearly 60 per cent. of the operating costs. For machine-picked cotton in 1947 operating costs averaged \$14.77 per bale or about \$1 per hundred pounds of seed cotton. Wastage and loss due to lowering of the grade when machine picked increased the cost to \$2.42 per hundred pounds.

454. Texas, Mechanized Production of Cotton in. H. P. Smith and D. L. Jones. (*Texas Agric. Exp. Sta. Bull.* 704, 1948, pp. 62.) This bulletin deals with the mechanical implements used in all operations connected with the production of cotton. Among the machines described are the roller stalk cutter for breaking up the residue of the previous crop, certain types of cultivators and seed and fertilizer distributors. Machines for weed control and the application of insecticides in spray

and dust form are listed, and details are given of cotton strippers and harvesters. The bulletin is copiously illustrated with excellent photographs and diagrams.

455. COTTON PICKER. By S. W. Grant. (*Text. Tech. Digst.*, 6, 6, 1949, p. 423.) This invention provides a cotton picker with a picker head comprising a casing formed at its forward wall with a guide trough adapted to receive a cotton stalk, the bottom of the trough having a slot extending its full length, and a pair of toothed rotors on each side of the slot. The toothed rotors rotate toward each other, and rotary brushes, rotating in the opposite direction and at different speeds from the toothed rotors, are situated behind them. The cotton fibres are caught up from the brushes by suction and deposited in a lint receptacle.

456. COTTON HARVESTERS: DOFFING MECHANISM FOR. By C. R. Berry. (*Text. Tech. Digst.*, 6, 6, 1949, p. 423.) This invention provides for the doffing of the carding cylinder of cotton pickers by a constant blast of air which blows the lint from the cylinder and into a lint receiver. In this manner, cracked seeds and other disadvantages of the revolving-brush type of doffer are eliminated.

PESTS, DISEASES, AND INJURIES, AND THEIR CONTROL

457. STATE RECOMMENDATIONS FOR THE CONTROL OF COTTON INSECTS, 1949. (*Nat. Cott. Coun. of Amer.*, Memphis.) This pamphlet quotes the recommendations for cotton insect control made by the individual cotton-producing States of the U.S.A. The recommendations were made public at the Second Annual Cotton Insect Control Conference, held in Atlanta, Georgia, December 6-7, 1948. A list of standard insecticides and the pests against which they are effective is included.

458. BOLL WEEVIL CONTROL WITH CHLORDANE, BENZENE HEXACHLORIDE, AND CALCIUM ARSENATE DUSTS. By C. H. Brett and W. C. Rhoades. (*J. Econ. Ent.*, 40, 4, 1947, p. 572. From *Rev. App. Ent.*, 37, Ser. A, 6, 1949, p. 205.) Field tests at Eufaula, Oklahoma, during the season of 1946 showed that talc dust containing 10 per cent. technical chlordane by weight and applied at the rate of 10 lb. per acre was about as effective against the boll weevil (*Anthonomus grandis*, Boh.) on cotton as calcium arsenate applied at 6 lb. per acre. BHC, which is a dust containing 5 per cent. γ isomer by weight applied at 10 lb. per acre, was somewhat more effective than either. The effectiveness of the control decreased as overlapping of weevil generations resulted in a daily re-establishment or increase of the population. Final yields showed about the same gain in a field in which calcium arsenate was applied a week after the appearance of the first squares, and twice more at weekly intervals, as in a less heavily infested one in which five applications were made throughout the season, each application being delayed until 25 per cent. or more of the squares had become infested.

Laboratory experiment showed that the susceptibility of the weevil to BHC increased as the temperature was raised, and that this was true to a less extent for chlordane. Dust containing 4 per cent. γ BHC was more toxic than dust containing 4 per cent. technical chlordane.

459. COTTON BOLLWORM, CORN AS A TRAP FOR. By C. Lincoln and D. Isely. (*J. Econ. Ent.*, 40, 3, 1947, p. 437. From *Rev. App. Ent.*, 37, Ser. A, 5, 1949, p. 160.) Maize in silk appeared to be effective in attracting moths of the cotton bollworm (*Heliothis armigera*) from cotton during a bollworm outbreak on cotton in Arkansas during the late summer of 1946. In exceptional instances, however, where cotton was heavily infected with Aphids, severe bollworm injury continued notwithstanding the proximity of the silking maize. In all instances of severe injury in this and previous outbreaks, no freshly silking maize was near the injured fields when the infestation of cotton began. Bollworm outbreaks appear to be favoured not only by the occurrence of Aphids, but also by dry, hot weather, which shortens silking during midsummer.

460. CONTROL OF *Empoasca lybica*, DE BERG., ON COTTON IN THE ANGLO-EGYPTIAN SUDAN. By J. W. Cowland and C. J. Edwards. (*Bull. of Ent. Res.*, 40, 1, 1949, p. 83.) The article opens with a short account of the life-cycle and symptoms of

damage of the cotton Jassid, *Empoasca lybica*, de Berg. In the initial cage experiments it is shown that DDT emulsion was superior to the copper compounds used. Experiments on the residual toxicity of DDT and "Gammexane" sprays are described. Tests with DDT emulsion showed that very young cotton is injured by emulsion containing as little as 0·025 per cent. DDT, but that emulsions containing up to 0·5 per cent. DDT can be used with safety on plants which are two months old. A coarse DDT suspension caused severe leaf distortion, but a fine suspension used later was quite safe at the concentration used. Field experiments with a power sprayer using various sprays were carried out at Gezira Research Farm. These were followed by large-scale spraying trials on 1,000 feddans at Kab el Gidad, 200 feddans at Abdel Magid, and 450 feddans in Turis. The sprays applied were copper oxychloride (Blitox) and DDT emulsion. Jassid counts were taken before and at intervals after treatment on the Gezira Research Farm and at Kab el Gidad. Copper oxychloride did not give good control of Jassids, but 0·1 per cent. and 0·05 per cent. DDT emulsion gave excellent kills and remained toxic to Jassids for 2-3 weeks. The benefit of spraying with DDT emulsion is amply demonstrated by the increased yield obtained on treated areas at Kab el Gidad, Abdel Magid and Turis.

461. Pink Bollworm, Carry-over from One Cotton Crop to the Next in the Lower Rio Grande Valley. By L. C. Fife *et al.* (*J. of Econ. Ent.*, **40**, 4, 1947, p. 540. From *Rev. App. Ent.*, **37**, Ser. A, 6, 1949, p. 199.) Investigations to determine how *Platyedra gossypiella*, Saund., maintains itself in the interval between one cotton crop and the next in the Lower Rio Grande Valley of Texas and Mexico were carried out in 1939-45. The larvæ were found to enter the resting stage in open cotton bolls in the field during the latter part of July, even though conditions were apparently still favourable for their development. Tests in hibernating cages showed that moths emerged in every month of the year from open cotton bolls on standing stalks, on the soil surface and at a depth of 1½ inches. Larvæ surviving the winter and available to produce moths to infest cultivated cotton averaged 20·4 per cent. of those from infested bolls on standing stalks, 8·5 per cent. of those from bolls on the soil surface, and 2·2 per cent. of those at a depth of 1½ inches. The winter survival from open bolls collected on August 8-16, September 11-18 and October 12-19 and put in hibernation cages averaged 0·4, 5 and 26 per cent. respectively. Moisture applied artificially to infested bolls in the three positions reduced winter survival in all cases. Over a period of two years, the average percentages of survival in watered and unwatered bolls were 33·6 and 49·7 on standing stalks, 15·5 and 21·7 on the soil surface, and 2·6 and 6·6 at a depth of 1½ inches, but the differences between the two series were not significant. According to moth emergence records in hibernation cages, the maximum durations of the larval diapause in open bolls in the three positions were 337, 276 and 276 days. Hibernation-cage tests showed that *P. gossypiella* can overwinter under natural conditions in the seed pods of *Pseudabutilon lozani* and *Hibiscus esculentus*, and it would therefore seem advisable to plough both cotton and okra crop residues under as early and as deep as possible. Irrigation or heavy winter rainfall will reduce winter survival, and early planting and the use of varieties of cotton that mature early will make it possible to destroy the crop residue at an early date, thereby reducing the overwintering population that causes infestation of the next crop.

462. Cotton Plant Insecticides. By W. M. Kulash. (*J. Econ. Entom.*, **41**, 1948, p. 986. From *Summ. Curr. Lit.*, xxix, **12**, 1949, p. 225.) Small-plot tests were made with dusts containing (i) Toxaphene (20 per cent.), (ii) γ-benzene hexachloride (3 per cent.) plus DDT (5 per cent.), (iii) γ-benzene hexachloride (5 per cent.), and (iv) Chlordan (5 per cent.) against boll weevil and bollworm. After five applications at 10 lb. per acre of each dust, γ-benzene hexachloride gave the lowest average weevil infestation, and Toxaphene the lowest bollworm infestation and highest yield of seed cotton.

463. Cotton Seed, Evaluation of Certain Substituted Phenol Esters for

THE TREATMENT OF. By C. H. Arndt. (*Phytopathology*, 38, 12, 1948, p. 978. From *Rev. App. Myc.*, xxviii, 6, 1949, p. 286.) At the South Carolina Agricultural Experiment Station cotton seeds infected by *Colletotrichum gossypii* were treated with various substituted phenyl esters, and the seeds germinated in sand culture at 24° C. At comparable dosages, the acetate of 2,4,5-trichlorophenol was effective in the prevention of seedling infection by *C. gossypii*, the formate and propionate esters slightly less so, and those of carbonate, succinate, and laurate ineffectual. The substitution of bromine for chlorine in the 2,4,6-trichlorophenyl acetates did not materially affect their efficiency. The position of the chlorine atoms in the benzene ring, however, did influence the fungicidal properties of the compounds. Thus, the 2,3,4,6-tetrachlorophenyl acetate was more toxic both to the pathogen and its host than the 2,4,5, while the chemicals with the chlorine atoms in the 2,4,6, the 2,3,6, and the 2,3,4,5,6 positions were rather less effective fungicides. The results of field plantings were in general agreement with those of the laboratory, and indicated that Seedox (the trade name of a dust containing 50 per cent. 2,4,5-trichlorophenyl acetate) at a dosage of 1 gm. per kg. seed is a satisfactory treatment for the elimination of anthracnose from fuzzy cotton seed.

464. EFFECT OF SOAKING COTTON SEED ON THE INCIDENCE OF ANGULAR LEAF SPOT IN NEW MEXICO AND ARIZONA. By A. R. Leding and L. A. Brinkerhoff. (*Phytopathology*, 37, 12, 1948, p. 974. From *Rev. App. Myc.*, xxviii, 6, 1949, p. 286.) Tests were carried out in 1942, 1943 and 1944 in New Mexico and Arizona to determine the efficiency of Boughey's method for the control of angular leaf spot of cotton (*Xanthomonas malvacearum*) by 48 hours' soaking of the seed at room temperature followed by air-drying with various modifications dictated by local conditions. Not only did the treatment fail to eliminate natural and artificial infection, but in nearly all the trials the incidence of blackarm was appreciably increased—*e.g.*, from 4·1 to 30·3, 9·7 to 58·1, 1·3 to 28·1, and 26·7 to 69·2 per cent. Evidently, therefore, the mechanism responsible for the efficacy of the water-soaking practice in the Sudan is not operative in the United States. The resultant increase of primary infection may, in fact, be of economic significance in Arizona and New Mexico, where growers occasionally soak fuzzy seed before planting to ensure rapid germination.

465. THE DISSEMINATION OF *Xanthomonas malvacearum* BY IRRIGATION WATER. By C. J. King and L. A. Brinkerhoff. (*Phytopathology*, 39, 1, 1949, p. 88. From *Rev. App. Myc.*, xxviii, 7, 1949, p. 332.) Evidence is presented to show that surface irrigation water may serve as an agent in the dissemination of *Xanthomonas malvacearum* in Arizona cotton fields. In a test carried out in 1943, both surface irrigation and sprinkling were effective in the diffusion of the pathogen. Acala bolls were collected in February from a field where angular leaf spot had occurred in the previous season, and in March they were spread across the upper end of a plot on which no cotton had been grown for several years. The soil was ploughed, irrigated and disked, and on March 23 disease-free SXP seed was planted. A good stand developed and a small percentage of Acala bolls produced seedlings. On April 27 about half the latter showed blackarm symptoms, but the SXP seedlings were healthy. On May 11 all the Acala seedling clumps were removed except five in line with the seed rows, and the next day a rotating lawn sprinkler was placed in the plot near the diseased seedlings. Withing ten days, most of SXP seedlings within the sprinkled area had also contracted blackarm, whereas all those outside it remained healthy. On the 22nd flood irrigation was applied to the entire plot, the seedlings being partially immersed for about one hour. On June 2 the stand was thinned to approximately 15 in. spacings and mapped for diseased seedlings. Blackarm was present below and immediately to the sides of the sprinkled area, involving about half the thinned stand, while the upper portion of the plot and the outside rows remained free from infection. Thus the disease had spread in the same general direction as the flow of the irrigation water. In two instances the pathogen had been carried to seedlings at the end of the plot, a distance of 25 ft. No rain fell between the time of planting and the final inspection of the plot.

466. STRIGA: EFFECT OF GERMINATION STIMULANT ON EXTENSION GROWTH ON THE ROOTS OF PEAS. By R. Brown *et al.* (*Nature*, **163**, 4,152, 1949, p. 842.) The seeds of *Striga hermonthica*, like those of certain closely allied parasites, will normally only germinate after they have been treated with a stimulant that is released from the roots of a large variety of species. The situation suggests that the parasite seed is supplied from actively growing host roots with a hormone which is normally required in germination but which is not synthesized by the seed. The possibility that the hormone may be one that stimulates extension growth in roots in general has been investigated by treating segments of pea roots taken from the extending zone with various dilutions of a solution of a concentrate of the hormone. The stimulant involved in the germination of the Striga seeds has not been isolated in the pure state; but it has been found that concentrates of the natural stimulant that give germination at high dilutions contain pentose sugars which are probably not aldopentoses, and that D-xyloketose may induce germination at lower concentrations than the purest preparations of the natural stimulant that have so far been made.

467. COTTON WILT AND NEMATODES: CONTROL WITH A SOIL FUMIGANT. By A. L. Smith. (*Phytopathology*, **38**, 12, 1948, p. 943. From *Rev. App. Myc.*, xxviii, 6, 1949, p. 286.) An amplified account of the successful experiments on the control of cotton wilt (*Fusarium oxysporum* f. *vasinfectum*) and nematodes by means of soil treatment with dowfume W-10 (10 per cent. ethylene dichromide and 90 per cent. naphtha B), a preliminary note on which has already appeared. (*Cf.* Abstract 217, Vol. XXVI of this Review.)

GENERAL BOTANY, BREEDING, ETC.

468. PROGRESS REPORTS FROM EXPERIMENT STATIONS, 1947-48. (Published by the Empire Cotton Growing Corporation, 1949. Price 3s. post free.) Progress reports are included summarizing the work carried out during the 1947-48 season at the experiment stations in Queensland, South Africa, Southern Rhodesia, Anglo-Egyptian Sudan, Uganda, Tanganyika Territory, Nyasaland, Nigeria, and the West Indies. The reports on the work in Queensland, Nigeria, Southern Rhodesia, Uganda, and the Leeward and Windward Islands of the West Indies are included by courtesy of their respective Governments. Useful work was continued at the stations in connection with cotton genetics and breeding, varietal trials, fertilizer experiments, rotation of crops, and in research on cotton pests and diseases. Programmes of experiments for the 1948-49 season are also included. These reports should prove of much interest and value to all who are concerned in any way with the cultivation of cotton and similar crops.

469. SOVIET GENETICS: THE REAL ISSUE. By J. Huxley. (*Nature*, **163**, 4,155/6, 1949, pp. 935, 974.) The author discusses fully the circumstances which culminated in the resolutions passed by the Præsidium of the U.S.S.R. Academy of Sciences on August 26, 1948. He reviews the correspondence submitted in connection with the controversy, and criticizes the claims made by Lysenko and other followers of the Michurin teaching. A warning is given against the far-reaching consequences of political interference in scientific research.

470. VARIABILITY AND CORRELATION IN A COTTON BREEDING PROGRAMME. By G. N. Stroman. (*J. of Agric. Res.*, **78**, 10, 1949, p. 353.) The simple, partial and multiple correlation coefficients were determined between characters in the cotton-breeding material of the New Mexico Agricultural Experiment Station for five years. These characters were: lint percentage, lint index, boll weight, classer's length, percentage of $1\frac{1}{8}$ in. (plus) fibres, mean length, length variability, three-fourths point, strength index, and fibre diameter. The material used was related selected progenies and these were given the complete laboratory tests. Lint percentage and lint index were positively correlated each year. Other significant correlations varied as to degree and relationship for the different years. The wide variability, even with the correlations, offers the possibility of combining all the desired characters of yield

and quality into one strain. This necessitates the use of a larger number of individuals from line-bred or hybrid material.

471. IMPROVEMENT OF WAGAD COTTON OF NORTH GUJARAT. By S. J. Patel. (*Ind. Cott. Grwg. Rev.*, iii, 2, 1949, p. 84.) The cotton crop of North Gujarat commercially known as "Dholleras" comprises three distinct varieties—viz., Wagad, Lalio, and Mathio. The total area under "Dholleras" cotton is about 2,500,000 acres, out of which about 1,300,000 acres (53 per cent.) is under Wagad cotton alone, with a production of about 300,000 bales of lint. Wagad cotton is a hardy variety and is adapted to a wide range of soil and climatic conditions. The bolls are smooth and globose and open only slightly when ripe—*i.e.*, it is a close boll type, on which account it is particularly suited for cultivation in windy tracts. The lint has a staple length of $\frac{3}{4}$ in. to $\frac{13}{16}$ in. capable of spinning 14 to 18 warpcounts. It is particularly suitable for mixing with other soft cottons for securing smooth spinning during monsoons when the humidity is high.

Work on the improvement of Wagad cotton was started in 1917 and resulted in the evolution of Wagad 8, which was found to be superior to local Wagad both in respect of yield of seed cotton and ginning outturn by 11 and 4 per cent. respectively. But as this type was slightly inferior to the local Wagad in quality, hybridization work was continued, and extensive crossing work was carried out between long-stapled, close-boll races of cotton from Iran, early cottons from Russia and outstanding Surtee-Broach types on the one hand and promising Wagad types on the other hand. From these crosses a type named Kalyan has been produced which has been found to be superior to all other types. The Indian Central Cotton Committee has sanctioned a scheme for distributing seed of this new strain, and it is hoped that it will soon occupy a prominent place in the cotton husbandry of North Gujarat.

472. ORGANIC ACIDS OF THE COTTON PLANT. By D. R. Ergle and F. M. Eaton. (*Plant Physiology*, **24**, 3, 1949, p. 373.) Organic acids, on the basis of dry weight, have been found to be present in the cotton plant in successively lower concentration in the leaves, petioles, flowers, stems, roots, young bolls, seed kernels, and lint. Leaves of cotton frequently contain 20 per cent. of organic acid on the basis of dry weight. Malic acid is usually present in greatest amount and tends to constitute 30 to 40 per cent. of the total organic acid. Without materially changing the concentration of total organic acid, drought was found to increase malic and decrease citric acid. This transformation of citric to malic is found to be a reversible reaction and apparently proceeds through some intermediate acid or acids which are included in the unidentified group. Comparisons of the disappearance of the carbohydrates and organic acids from excised and attached leaves during five days in the dark point to the conclusion that the respiration and translocation of organic acids proceeds only about one-fifth as rapidly as does that of sugars. The carbohydrates were largely exhausted during the five days. It is possible that respiration of organic acids does not occur until the labile carbohydrates are nearly exhausted. As evidence of this it was found in another experiment that there was no loss of organic acid in an initial 24-hour period during which a large store of labile carbohydrates was maintained. Consistent correlations were not found between variations in the concentrations of the organic acids and the sugars, starch, or soluble and insoluble nitrogen.

FIBRES, YARNS, SPINNING, WEAVING, ETC.

473. PLANT FIBRES: ELECTRON MICROGRAPHY. K. Mühlethaler. (*Biochim. et Biophys. Acta*, **3**, 1949, p. 15. From *J. Text. Inst.*, **40**, 6, 1949, p. A245.) Electron micrographs of unaltered cell-wall structures have been obtained by using a Waring Blendor for preparing the fibre sections and by metal shadowing the specimen preparations before microscopy. The cell walls of ramie, cotton, flax, sisal and wood fibres have been examined. In all these fibres the cellulose consists of completely individualized microfibrils having a thickness of about 250-400Å. In primary

walls the microfibrils are intertwined to form a network, but in secondary walls they have a common direction and thus are arranged in a more or less parallel manner. Non-cellulose substances, such as lignin, pectin, wax and hemicellulose, are embedded between such fibrils and can be extracted from the cell walls and leave the fibrils undisturbed, indicating that cellulose and non-cellulose each form an independent system.

474. Raw Cotton: Maturity Determination. By K. Vogler. (*Textil-Rundschau*, 4, 1949, p. 75. From *J. Text. Inst.*, **40**, 6, 1949, p. A245.) The development of the cotton fibre is outlined and microscopical methods for the determination of its degree of maturity are reviewed. The dyeing technique of Goldthwait has been tested and its application to raw cotton, staple diagrams, and cotton yarns are illustrated. (*Cf.* Abstr. 396, Vol. XXV of this Review.)

475. A Simplified Sliver Tester. By J. U. Steiger. (*J. Text Inst.*, **40**, 5, 1949, p. T253.) A description is given of a machine by which variations in the thickness of cotton slivers are mechanically measured and charted. Greater dimensional tolerance is permissible than in previous designs, resulting in a relatively low cost of manufacture. Examples of the use of the machine in detecting sliver faults are given.

476. Long Fine Cottons: Drafting on "Super-Draft" Roving Frames. By J. R. Corley. (*Text. Industrs.*, **113**, 1949, p. 110. From *Summ. Curr. Lit.*, xxix, **11**, 1949, p. 199.) Trial runs with the "Super-Draft" roving frame have indicated that the manufacturers' draft gear tables are more suitable for processing short-staple cotton than for long cotton. The application of draft factors to obtain product uniformity in drafting long, fine cottons is considered and a new draft guide is presented, whereby a higher level of roving uniformity can be secured with the system when processing these cottons. Details are given of the manufacture of the roving used in the study and of the test procedure.

477. Method and Apparatus for Spinning Cotton and Other Textile Fibres. By J. S. Mayo. (U.S. Patent 2,451,504, October, 1948. From *Text. Tech. Dgst.*, **6**, 7, 1949, p. 526.) A method and apparatus are provided for opening, cleaning, and parallelizing cotton, and other textile fibres, by means of a series of chambers in which the fibres are delivered through a small opening to a twister for the imparting of twist and collection upon a bobbin.

478. Cotton Waste: Processing. (*Platt's Bull.*, **6**, 1948, p. 109; **6**, 1949, p. 128.) *From Summ. Curr. Lit.*, xxix, **12**, p. 226.) Types of opening and cleaning machines recommended for soft cotton wastes, including the Crighton opener, the Pickering machine, and the Premier opener, are briefly described and illustrated. The English and the Continental systems of carding of cotton wastes for the production of condenser yarns are described and their relative advantages discussed. Typical production data are shown.

479. Deterioration of Cotton Textiles exposed to the Weather. By H. Bogaty. (*Amer. Dyest. Reptr*, **38**, 6, 1949, p. 253. From *Rev. App. Myc.*, xxviii, **8**, 1949, p. 395.) The data here presented are part of those obtained in the course of an inquiry into some aspects of "tropical" deterioration of cotton textiles initiated at the National Bureau of Standards, Washington, D.C., early in 1945 at the request of the National Defence Research Committee. It was found that cotton fabrics treated against mildew with copper naphthenate deteriorated more rapidly on outdoor exposure than did untreated samples. Free copper sulphate does, in general, contribute to the acceleration of tendering. Copper naphthenate prepared in the laboratory from copper acetate was not so effective a fungicide as commercial copper naphthenate under conditions involving soil contact. Phenyl salicylate (salol), an ultra-violet radiation-absorber, did not inhibit or reduce the degradation of copper naphthenate-treated cotton exposed to weathering, but an anti-oxidant, pyrogallol (2 per cent. plus 0·8 per cent. copper naphthenate), gave some promise in this respect, and further experiments with it should be undertaken. The rôle of the agencies comprising "weather" requires further elucidation. Fabrics lose copper when exposed in a dry climate without rainfall, so that the amount of

precipitation cannot be the sole climatological factor concerned in the disappearance of the fungicide. Fabrics treated with copper phenyl naphthenate deteriorated at about the same rate as the copper naphthenate-treated samples in weathering exposures, but were somewhat more resistant to soil contact.

TRADE, PRICES, NEW USES, ETC.

480. INTERNATIONAL COTTON ADVISORY COMMITTEE. (*Cotton*, M/c., 7/5/49.) At the recent meeting at Brussels, the Committee agreed that the present state of the raw cotton market should be treated in the first instance as under-consumption rather than as over-production. It was noted that cotton was 30 per cent. dearer than rayon in the United Kingdom and 20 per cent. dearer in France. In the United States prices are about the same. In addition, the Committee will study the size of the prospective market for cotton textiles having regard to the factors which have impeded the growth of consumption in recent years, notably rationing and currency difficulties. It was noted, too, that in many parts of the world the growth of textile consumption has not kept pace with the growth of population. Member Governments are to be asked to create national co-ordination agencies with a view to strengthening the statistical data and information on duties, regulations and other factors affecting the import, export, and consumption of cotton. A scheme for securing a balance between world cotton production and consumption is to be prepared for discussion at the Committee's next meeting, which will be held in the United States in 1950.

481. THE EUROPEAN COTTON SITUATION. By C. Robertson and R. P. Dunn. (Nat. Cott. Council, Tennessee, 1949.) This report gives a comprehensive survey of the Supply and Demand for Textile Fibres in Europe. It deals with the status of the industry in individual countries and includes statistics for consumption and exports of both cotton and rayon. The shortage of cotton is found to be the principal factor limiting consumption in all European countries at the present time. In most countries equipment is adequate to permit expansion. Labour is a serious restriction in England and Czechoslovakia, and power is a limitation in Spain. While several countries are consuming at rates above pre-war, cotton consumption in Europe as a whole is almost 2·4 million bales, or 20 per cent., less this season than in 1938-39. Cotton consumption goals for 1949-50 for Europe as a whole are about 9 per cent. higher than for this year. This would be 88 per cent. of 1938-39. Realization of these goals will require the full 3·5 million bales of United States cotton proposed for countries under Economic Co-operation Administration plus another 500,000 bales of United States cotton purchased independently. In addition they will require about 6·5 million bales of non-United States cotton, which is considered the maximum other producing countries will be able to supply. Because of the dollar shortage any reduction in the E.C.A. cotton programme would undoubtedly limit consumption.

Rayon production is increasing rapidly in an effort to reduce dollar expenditures for cotton. In 1939 synthetic production was equivalent to about 3 million bales—*i.e.*, about 25 per cent. of cotton consumption. The current rate is over 4 million bales—*i.e.*, about 45 per cent. of cotton consumption. Production goals for synthetics in 1950 are equivalent to over 5 million bales—*i.e.*, about 50 per cent. of cotton-consumption goals. Europe's exports of cotton products are now only 45 per cent. of pre-war, while exports of rayon products are 135 per cent. The conclusion drawn from the study is that the primary problem in maintaining United States cotton exports will be increasing dollar purchasing power sufficient to permit continued purchases in that country. Forms and types of credits necessary to expedite trade are suggested, proposals of exchanges of cotton against critical commodities are discussed, and programmes for expanding East-West trade with cotton are advanced as interim means of furthering cotton exports.

482. COTTON CARRY-OVER, 1948-49 CROP. (*Cotton*, Int. Cott. Adv. Cttee., July, 1949.) The global carry-over of cotton at the end of the 1948-49 season is estimated

at 15 million bales. In appraising this stock level, attention has to be given to both past and prospective developments. A decade ago, just prior to the outbreak of World War II, the carry-over at 23 million bales was at one of the highest levels ever reached in peace-time. It was equivalent to nine months' consumption. Except in the light of its subsequent strategic value, this carry-over could be regarded as burdensome under pre-war trading conditions. The carry-over at the end of the current season is approximately two-thirds of this pre-war carry-over and is equivalent to six and a half months' consumption at the 1948-49 rate. From the standpoint of consumption, therefore, it does not appear to have reached unduly heavy proportions. On the other hand, the carry-over has increased by one million bales during the past season due to production and consumption moving in opposite directions.

483. COTTON: QUARTERLY STATISTICAL BULLETIN. (Int. Cott. Adv. Cttee., 1, 3, 1949.) Contains tables covering world supply and distribution, production, consumption and exports, and imports of cotton into the principal manufacturing countries by growths.

MISCELLANEOUS

484. RAYON AS A COMPETITOR OF COTTON. By R. B. Evans. (*Production Studies of Synthetic Fibres and Paper*, Project V, U.S. Govt. Printing Office, Wash., 1947.) For many years American cotton has faced increasing competition from substitute materials and from foreign growths. As a result, cotton growers, processors and the Government find themselves under the necessity of making vitally important decisions in regard to whether less cotton should be planted in the south, whether changes in price control measures are desirable or necessary, and whether a vastly expanded research and merchandizing programme should be undertaken.

Rayon deserves individual attention in any study of cotton's competitors. It has already displaced considerable quantities of cotton and wool, as well as silk, in clothing and household fabrics. It is now also proving to be an important competitor of cotton in its most important industrial use, tyre fabrics. Continued research through the years has made rayon more and more suitable for various textile requirements. At the same time, its price has been reduced until in 1946 it was available at a lower cost than most cotton. The increasing pressure of rayon on cotton's end-use markets was not reflected in cotton-consumption totals during the war because of the large unprecedented demand for textiles of all sorts. With the inevitable return to a buyer's market, it will be more important than ever before for those having a stake in cotton to understand the nature and extent of the competition offered by rayon.

485. PECTOSOL-CEMENT ROAD-BUILDING PROCESS. (*E. Afr. and Rhod.*, 18/8/49.) A new process for road construction has been discovered which it is estimated will reduce the cost of constructing permanent roads in Africa to one-tenth or less of the present figure. It has been found that the waste material of the sisal plant or groundnut husks, when finely ground and treated, can be made into an efficient soil stabilizer. The preparation has been patented under the name of Pectosol. Laboratory tests indicate that a mixture of one and a half parts of Pectosol with one and a half parts of cement, a total of three parts of stabilizing material in a hundred parts of soil and stabilizer together, give a higher load-bearing strength than the usual 10 per cent. cement mixture. Brick earth, laterite, chalk and clay have all been satisfactorily treated in this way, and experts are confident that black cotton soil in Africa will likewise yield to this simple economical treatment. Soils containing up to 30 per cent. of stones require no special treatment, but it is not expected that pure sand and volcanic dust could be used successfully. Large-scale production in several African territories is planned if field tests already arranged in Kenya, Tanganyika and Nigeria are successful.

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